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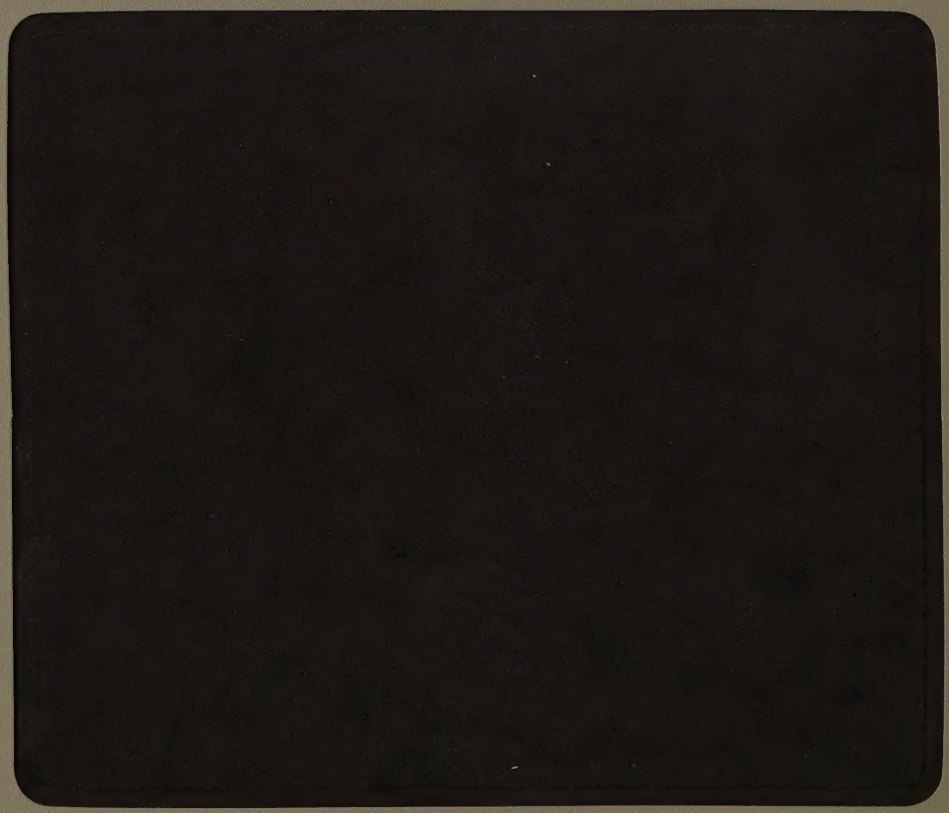

1780A
InfoTouch Display

Instruction Manual

P/N 630798
July 1982 Rev. 2 11/86
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WARRANTY

John Fluke Mfg. Co., Inc. (Fluke) warrants this instrument to be free from defects in material and workmanship under normal use and service for a period of 1 year from date of shipment. Software is warranted to operate in accordance with its programmed instructions on appropriate Fluke instruments. It is not warranted to be error free. This warranty extends only to the original purchaser and shall not apply to fuses, computer media, batteries or any instrument which, in Fluke's sole opinion, has been subject to misuse, alteration, abuse or abnormal conditions of operation or handling.

Fluke's obligation under this warranty is limited to repair or replacement of an instrument which is returned to an authorized service center within the warranty period and is determined, upon examination by Fluke, to be defective. If Fluke determines that the defect or malfunction has been caused by misuse, alteration, abuse, or abnormal conditions of operation or handling, Fluke will repair the instrument and bill purchaser for the reasonable cost of repair. If the instrument is not covered by this warranty, Fluke will, if requested by purchaser, submit an estimate of the repair costs before work is started.

To obtain repair service under this warranty purchaser must forward the instrument, (transportation prepaid) and a description of the malfunction to the nearest Fluke Service Center. The instrument shall be repaired at the Service Center or at the factory, at Fluke's option, and returned to purchaser, transportation prepaid. The instrument should be shipped in the original packing carton or a rigid container padded with at least four inches of shock absorbing material. FLUKE ASSUMES NO RISK FOR IN-TRANSIT DAMAGE.

THE FOREGOING WARRANTY IS PURCHASER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE OR USE. FLUKE SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OR LOSS WHETHER IN CONTRACT, TORT, OR OTHERWISE.

CLAIMS

Immediately upon arrival, purchaser shall check the packing container against the enclosed packing list and shall, within thirty (30) days of arrival, give Fluke notice of shortages or any nonconformity with the terms of the order. If purchaser fails to give notice, the delivery shall be deemed to conform with the terms of the order.

The purchaser assumes all risk of loss or damage to instruments upon delivery by Fluke to the carrier. If an instrument is damaged in-transit, PURCHASER MUST FILE ALL CLAIMS FOR DAMAGE WITH THE CARRIER to obtain compensation. Upon request by purchaser, Fluke will submit an estimate of the cost to repair shipment damage.

Fluke will be happy to answer all questions to enhance the use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WA 98206, ATTENTION: Sales Department. For European Customers: Fluke (Holland) B.V., P.O. Box 5053, 5004 EB, Tilburg, The Netherlands.

FCC WARNING

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

For RS-232 communications, use Fluke Y1703, Y1705, Y1707, or Y1708 fully shielded cables, or equivalent, to maintain compliance with FCC rules.

1780A RFI INFORMATION

CAUTION

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

For RS-232 communications, use Fluke Y1703, Y1705, Y1707 or Y1708 fully shielded cables, or equivalent, to maintain compliance with FCC rules.

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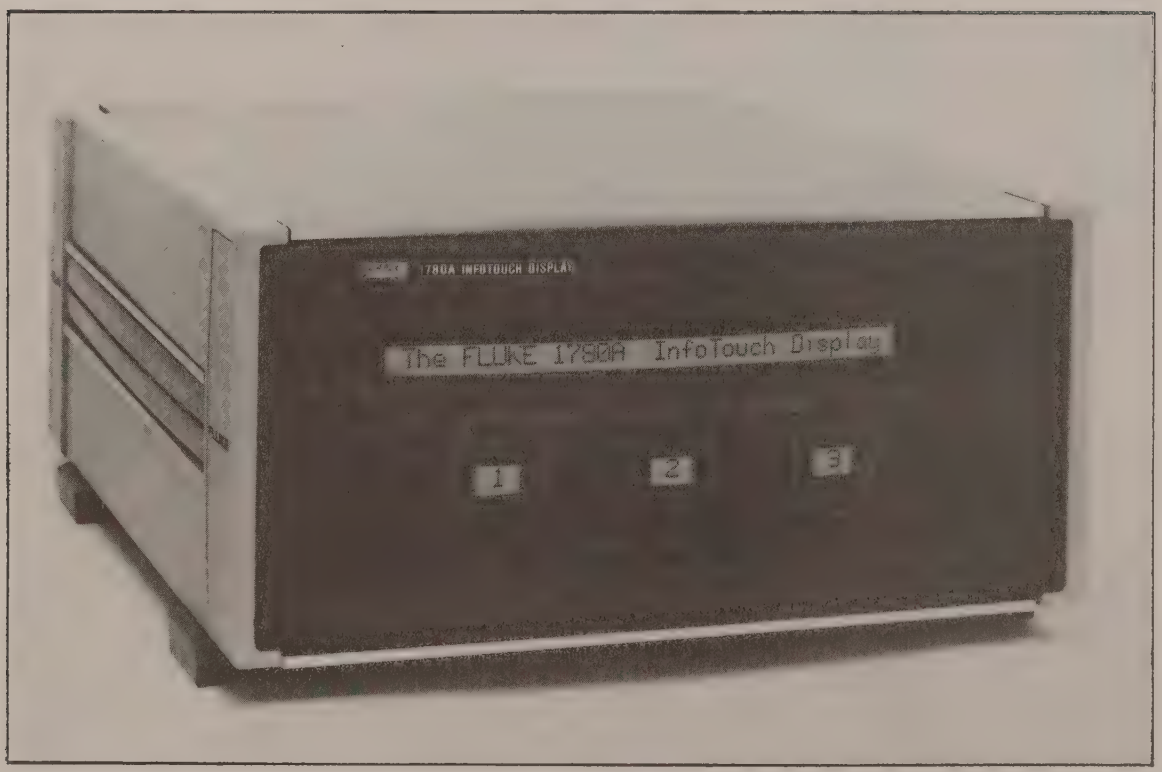

1780A InfoTouch Display

INTRODUCTION

The Fluke Model 1780A InfoTouch Display is a sophisticated but friendly, easily configured interface between human operators and computer driven systems. The 1780A interprets character strings from the host computer into displays that provide the operator with information or that ask the operator to make a choice. The operator responds in a natural manner by pointing to the appropriate choice and touching the display lightly. The 1780A, acting as a software configured keyboard, tells the host computer that a particular area was touched.

The 1780A has 60 touch-sensitive areas arranged in 6 rows and 10 columns. The host computer can program any or all of these areas to respond to touch.

The 1780A can display all 128 characters in the standard character set (see Subsection 4A) in 16 lines with 80 normal-sized characters each or in 8 lines with 40 double-sized characters each. These characters can be enhanced by any combination of highlighting, blinking, underlining, or reversing the video block. Optional alternate character sets are available to expand the 1780A capability up to 256 characters. These sets, such as special graphics, are described in the options sections of this manual. If you have a PROM Programmer, you can also design your own character set.

The flexibility of the display combined with the touch-sensitive areas on the screen allow the 1780A to be used to virtually eliminate operator training and to simplify complex system operation. Each piece of information or operator decision in system operation can be displayed sequentially on the 1780A to focus the operator's attention on relevant choices and to protect the operator from making inappropriate choices.

The 1780A has the following additional features:

- High contrast green phosphor display for operator eye comfort.
- Display refresh is automatically set to either 50 Hz or 60 Hz. The 1780A automatically senses line frequency and sets display refresh to the appropriate rate.
- RS-232-C serial interface port with selectable baud rates in standard increments up to 9,600.
- Partial and full screen erasing.

- Direct cursor addressing.
- Programmable cursor type: a steady or blinking reverse video block or no cursor at all.
- Character graphics.
- Rack mount capability.
- Optional interface for the Y1720 Programmer Keyboard accessory (standard ASCII keyboard) or a user designed keyboard.

CONVENTIONS USED IN THIS MANUAL

In this manual, groups of characters that indicate a control function or a code number are enclosed by angle brackets: < >. Table 1-1 lists some of the control codes defined in this manual.

Table 1-1. Control Code Conventions

MNEMONIC	DEFINITION
<ESC>	Escape
<CR>	Carriage Return
<LF>	Line Feed
<n>	ASCII Character Code (decimal number)

OPTIONS AND ACCESSORIES

Table 1-2 lists the options and accessories available for use with the 1780A. Section 8 of this manual describes the options and accessories in detail.

SPECIFICATIONS

Table 1-3 lists the 1780A specifications.

Table 1-2. 1780A Options and Accessories

OPTION/ACCESSORY NUMBER	DESCRIPTION
OPTIONS	
1780A-001	Keyboard Interface
1780A-002	Keyboard Interface With Y1720 Programmer Keyboard
1780A-201	Extended Graphics Character Set
ACCESSORIES	
Y1703	4 meter RS-232 Null-Modem Cable
Y1705	0.3 Meter RS-232 Null-Modem Cable
Y1707	2 Meter RS-232 Cable
Y1708	10 Meter RS-232 Cable
Y1720*	Programmer Keyboard (full ASCII keyboard)
Y1718*	Customizing Keyboard Cable
Y1791	1780A Rack Mount Adapter**
Y1792	1780A Rack Mount Adapter with Front Panel Keyboard Connector Extension**
M00-260-610	18-inch Rack Slide Kit
M00-280-610	24-inch Rack Slide Kit
Y1793	Carry Handle***
533547	Display Worksheets (Pad of 50)

* Requires the optional 1780A-001 Keyboard Interface.
** Requires a rack slide kit: M00-260-610 or M00-280-610.
*** Can be installed on either side.

Table 1-3. 1780A Specifications

GENERAL SPECIFICATIONS

Power

Voltage	90 to 132V ac and 198 to 264V ac
Frequency	47 to 63 Hz
Power Dissipation	40 watts, typical 55 watts, maximum

Temperature

Operating	0 to +50°C
Non-operating	-40 to +65°C

Relative Humidity

0 to 25°C	95% non-condensing
25 to 40°C	75% non-condensing
40 to 50°C	45% non-condensing

Altitude

Non-operating	12,000m (40,000 ft)
Operating	3,000m (10,000 ft)

Size (See Figure 1-1)

High	13.3 cm (5.2 ")
Wide	29.0 cm (11.4 ")
Deep	34.5 cm (13.6 ") plus the front bezel extension

Weight ..... 8.5 kg (18.75 lbs)

Protection Class 1 as defined in I.E.C. Publication 348 "Safety Requirements For Electronics Measuring Apparatus"

CRT DISPLAY SPECIFICATIONS

Scanning Method	Non-interlaced raster scan.
Refresh Rate	50 or 60 Hz, automatically selected.
CRT Screen	High contrast green phosphor, 19 cm wide by 7.6 cm high (7.5 " wide by 3.0 " high), low profile, rectangular.
Display Capacity	16 X 80 normal-sized cells or 8 X 40 double-sized cells.
Standard Character Set	96 ASCII characters (Listed in Table 4A-1) plus 11 Greek character, 11 Standard Graphics Mode characters, and 8 commonly used symbols.

Table 1-3. 1780A Specifications (cont)

CRT DISPLAY SPECIFICATIONS (cont)	
Character Font	7 X 9 (dots) in an 8 X 14 matrix.
Character Enhancements	Reverse video, blinking, underlining, and highlighting.
Cursor	Blinking or steady reverse video block or no cursor at all. Remote selectable only.
Screen Brightness	Adjustable with rear panel control.
Cell Size	
Standard Size	2.4 X 4.8 mm (0.094 X 0.188 ")
Double Size	4.8 X 9.5 mm (0.188 X 0.375 ")
Character Size	
Standard Size	2.1 X 2.7 mm (0.082 X 0.121 ")
Double Size	4.2 X 5.4 mm (0.100 X 0.241 ")
Display Alignment	Character with respect to touch-sensitive grid at 25°C: ±1 character horizontal ±0.75 character vertical Change in character positions over the Operating Temperature Range: <= 1.5 characters horizontal <= 0.3 character vertical

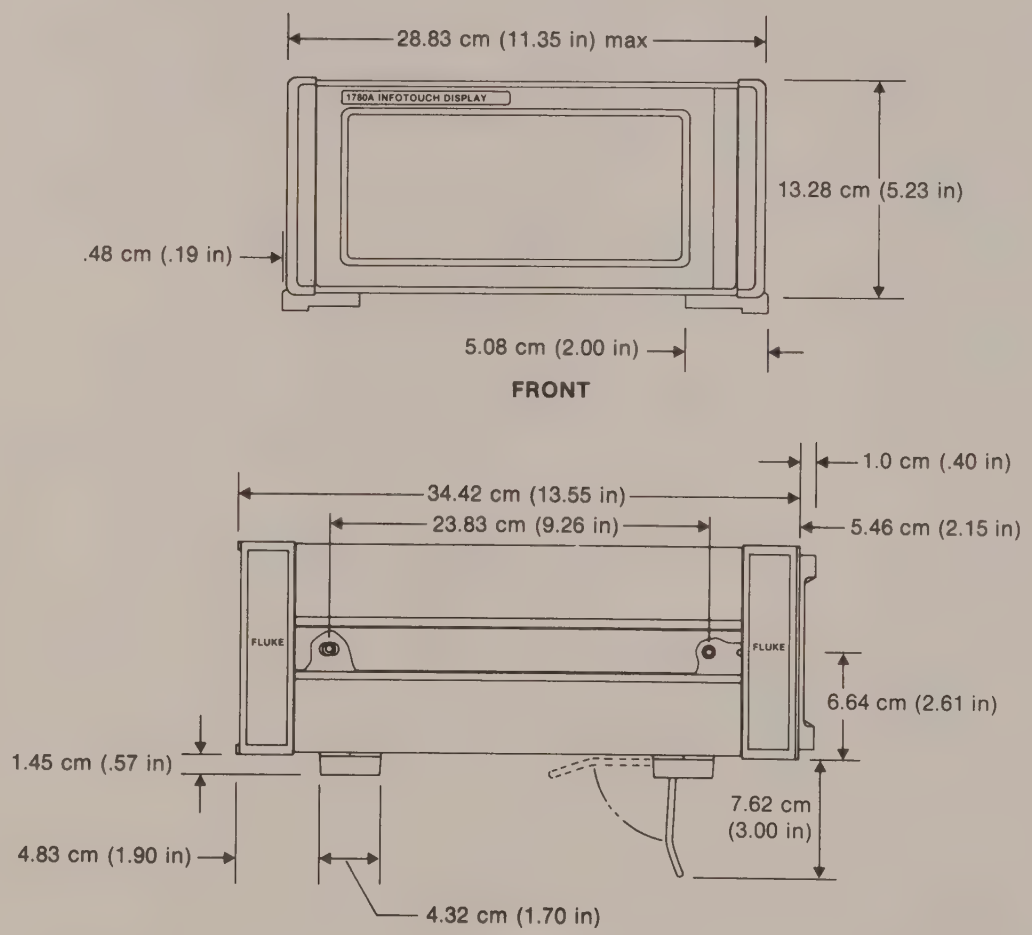

Figure 1-1. 1780A Outline Drawing

Section 2
Shipping, Service, and Installation Information

INTRODUCTION

The information in this section describes how to prepare the 1780A for operation. The shipping information describes unpacking and reshipment procedures. The service information describes the service plan for the 1780A. The installation information helps you configure the 1780A to your specific application.

SHIPPING INFORMATION

Upon receipt, inspect the 1780A thoroughly for possible shipping damage. Special instructions for inspection and claims are included in the shipping container. Check the contents of the shipping container to insure that everything listed in the Packing List (Table 2-1) is included.

If reshipment is necessary, use the original container or order a new container from your local John Fluke Sales or Service Center or from the John Fluke Mfg. Co., Inc.; P.O.Box C9090; Everett; WA 98026; telephone (800) 426-0361. When ordering a new shipping container, be sure to state that the container is for a 1780A.

Table 2-1. Packing List

ITEM	QUANTITY
1780A InfoTouch Display	1
1780A Power Cord	1
1780A Instruction Manual	1
Programming Worksheet (Pad of 50)	1

SERVICE INFORMATION

Factory authorized service is available at John Fluke Service Centers (listed at the back of this manual). If requested, you will be provided with an estimate before work is begun on instruments that are beyond the warranty period.

A Module Exchange Program is available for field repair of the 1780A. Section 6 contains troubleshooting procedures that help locate a faulty module.

The 1780A Maintenance Kit and the CRT Repair Kit are available for module level support of the 1780A. See Section 7 for the appropriate Fluke Part Numbers.

INSTALLATION

Introduction

The following paragraphs provide the information necessary to configure the 1780A to your specific application. Among other things, this information describes how to properly mount the 1780A, to select the correct line power configuration, to establish specific parameters such as baud rate, and to connect the 1780A to the RS-232-C interface. When you complete this section, the 1780A is ready to operate as directed by the host computer. Section 3 describes operation of the 1780A. Section 4 provides programming information.

Rack Mounting

The 1780A can either be placed on a table, rack mounted, or custom-installed into your system cabinet. Table 2-2 lists each of the rack mount accessories available for use with the 1780A. Each of these is described in Section 8 of this manual.

The Y1792 includes an extension cable and a panel mounted connector to bring the optional 1780A-001 Keyboard Interface forward to a front filler panel. Both the Y1791 and the Y1792 can be assembled with the 1780A against either the right or left side. Each requires either an 18-inch or a 24-inch Rack Slide Kit for proper mounting.

Table 2-2. Rack Mount Accessories

ACCESSORY NO.	NAME
Y1791	1780A Rack Mount Adapter
Y1792	1780A Rack Mount Adapter With Front Panel Keyboard Connector Extension*
M00-260-610	18-inch Rack Slide Kit
M00-280-610	24-inch Rack Slide Kit

* Requires the -001 Keyboard Interface.

Line Power Fuse Replacement and Voltage Selection Procedure

INTRODUCTION

The following procedures allow the user to replace the line power fuse and to select the line power voltage configuration.

LINE POWER FUSE REPLACEMENT PROCEDURE

To replace the line power fuse, perform the following procedure on the 1780A rear panel using Figure 2-1 for reference:

1. Set the POWER switch to OFF and disconnect the line power cord from the 1780A.

2. Slide the transparent MAIN POWER FUSE cover toward the power receptacle.

3. Hold one hand under the fuse area to catch the fuse and pull the FUSE PULL tab out. The fuse will drop into your hand.

4. Replace the fuse with the correct type:

   a. For 100V ac or 120V ac, replace with a 1A, 250V fast-blow fuse.

   b. For 220V ac or 240V ac, replace with a 1/2A, 250V fast-blow fuse.

5. Close the fuse compartment and connect the power cord.

LINE POWER VOLTAGE CONFIGURATION

CAUTION

Incorrect voltage selection may damage your 1780A and void your warranty.

To select the line power voltage, perform the following procedure on the 1780A rear panel using Figure 2-2 for reference:

1. Complete steps 1, 2, and 3 of the Line Power Fuse Replacement Procedure.

2. Locate the voltage select pcb (under the fuse) in the fuse compartment.

3. Pull the pcb from its slot by inserting a scribe or long nose pliers into the pull hole in the pcb.

4. Position the pcb between the thumb and forefinger of your left hand until the desired voltage (100, 120, 220, or 240) appears upright on the thumb side.

5. Position the free end of the pcb into the slot so that the selected voltage is on top and to the left (normal reading position). Figure 2-2 shows the pcb in the 120V position.

6. Press the pcb into the slot.

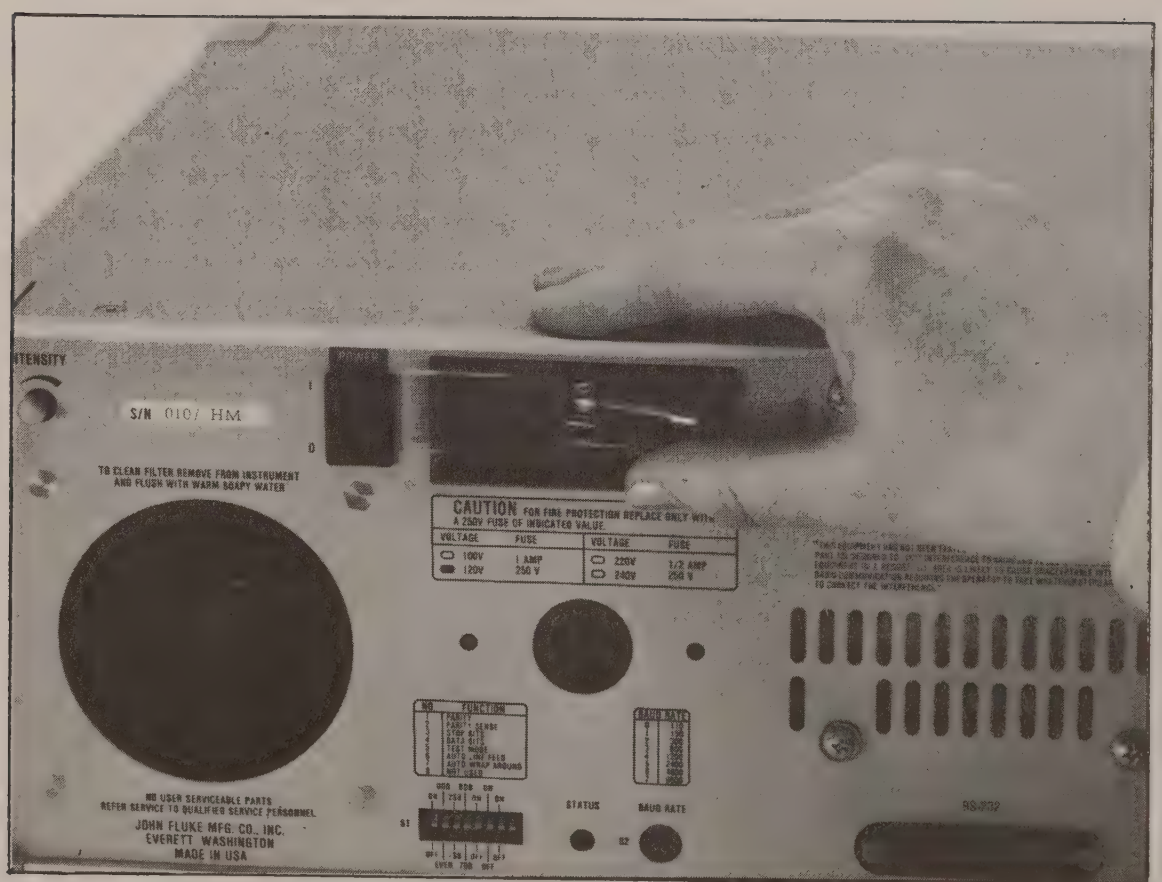
S/N 010/ HM
TO CLEAN FILTER REMOVE FROM INSTRUMENT AND FLUSH WITH WARM SOAPY WATER
CAUTION FOR FIRE PROTECTION REPLACE ONLY WITH A 250V FUSE OF INDICATED VALUE
VOLTAGE FUSE VOLTAGE FUSE
100V 1 AMP 220V 1/2 AMP
120V 250 V 240V 250 V
NO USER SERVICEABLE PARTS REFER SERVICE TO QUALIFIED SERVICE PERSONNEL
JOHN FLUKE MFG. CO., INC.
EVERETT WASHINGTON
MADE IN USA
FUNCTION
BAUD RATE
STATUS
BAUD RATE
RS-232

Figure 2-1. Line Power Fuse Replacement

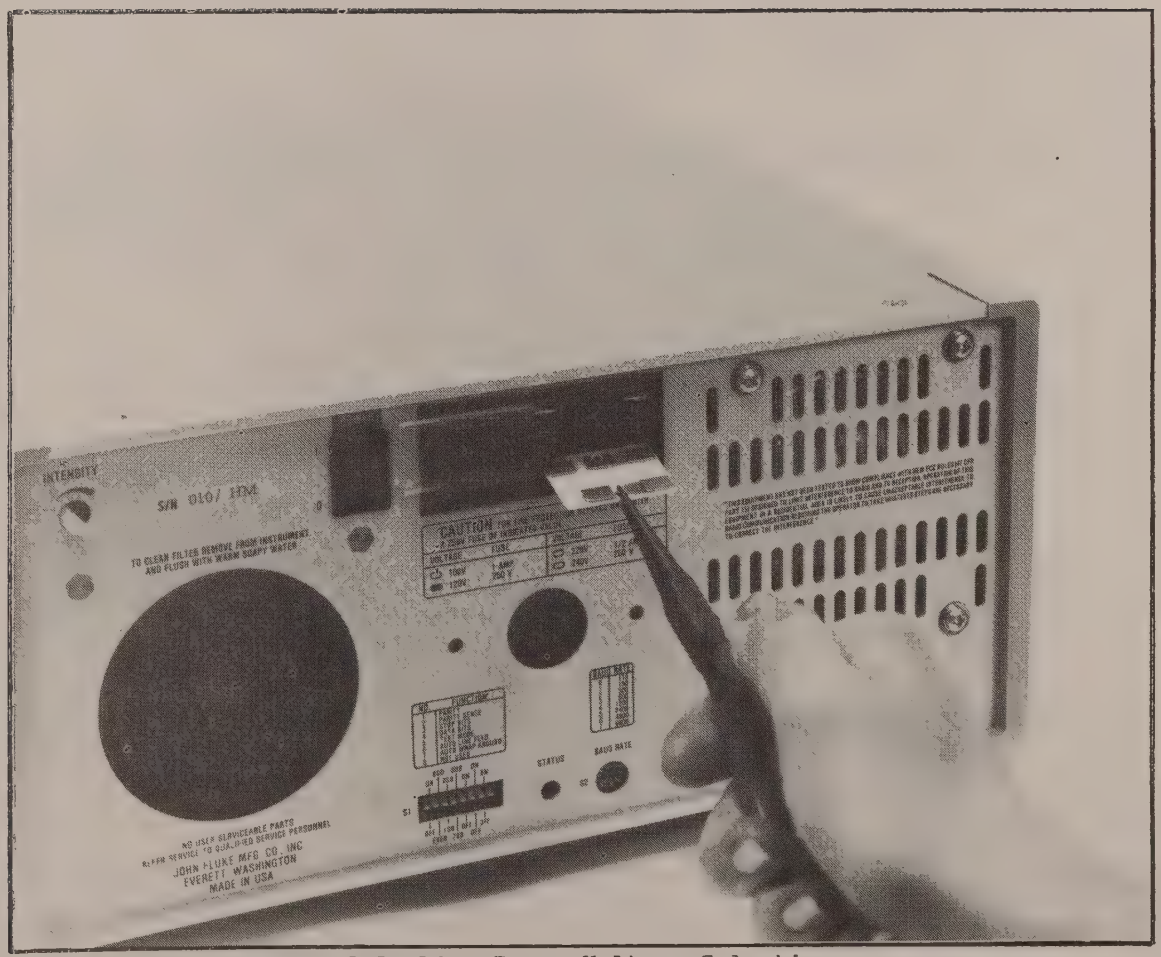

Figure 2-2. Line Power Voltage Selection

7. Check the fuse to accommodate the selected voltage. Change the fuse if necessary.

   a. For 110 or 120V ac use a 1A, 250V fast-blow fuse.

   b. For 220 or 240V ac use a 1/2A, 250V fast-blow fuse.

8. Close the fuse compartment and connect the power cord.

Rear Panel FUNCTION Switches

The rear panel FUNCTION switches allow you to set RS-232-C communication parameters for the 1780A such as baud rate and parity. If the 1780A is to be mounted in a rack that does not have convenient rear access, make sure that these switches are set to the configuration you want before the 1780A is placed in the rack. Table 2-3 lists each of the rear panel FUNCTION switches and provides a brief description of each switch.

Table 2-3. Rear Panel FUNCTION Switches

<table>
<tr><th>SWITCH NAME</th><th>POSITION</th><th>DESCRIPTION</th></tr>
<tr><td>BAUD RATE</td><td>Rotary</td><td>If the TEST MODE Function Switch is in the OFF position, the BAUD RATE switch selects one of nine standard baud rate settings. When in the ON position, the BAUD RATE switch selects one of the self tests described in Section 6.

<table>
<tr><th></th><th>TEST MODE SWITCH SETTING
(OFF)</th><th>(ON)</th></tr>
<tr><th>POSITION</th><th>BAUD RATE</th><th>TEST FUNCTION</th></tr>
<tr><td>0</td><td>110</td><td>ALIGN</td></tr>
<tr><td>1</td><td>150</td><td>ALIGN</td></tr>
<tr><td>2</td><td>300</td><td>REV VIDEO</td></tr>
<tr><td>3</td><td>600</td><td>TEST CHRS</td></tr>
<tr><td>4</td><td>1200</td><td>TSO TEST</td></tr>
<tr><td>5</td><td>2400</td><td>ALIGN</td></tr>
<tr><td>6</td><td>4800</td><td>ALIGN</td></tr>
<tr><td>7</td><td>9600</td><td>ALIGN</td></tr>
<tr><td>8</td><td>NA</td><td>ALIGN</td></tr>
<tr><td>9</td><td>NA</td><td>ALIGN</td></tr>
</table></td></tr>
<tr><td>PARITY</td><td>ON</td><td>Checks and generates parity according to the position of the PARITY SENSE switch.</td></tr>
<tr><td></td><td>OFF</td><td>Does not check or generate parity.</td></tr>
</table>

Table 2-3. Rear Panel FUNCTION Switches (cont)

SWITCH NAME	POSITION	DESCRIPTION
STOP BITS	1	The minimum spacing between transmitted characters is one bit-cell time period.
	2	The minimum spacing between transmitted characters is two bit-cell time periods. This requirement is not imposed on incoming data.
PARITY SENSE	EVEN	Selects even parity (each character will contain an even number of 1- bits.) The PARITY Switch must be ON for the PARITY SENSE Switch to be effective.
	ODD	Selects odd parity (each character will contain an odd number of 1- bits). The PARITY Switch must be ON for the PARITY SENSE Switch to be effective.
DATA BITS	7	Each character includes 7 data bits. Additional incoming data bits are ignored.
	8	Each character includes 8 data bits. Additional incoming data bits are ignored.
TEST MODE	OFF	The 1780A operates normally.
	ON	The 1780A is in the Test Mode described in Section 6 of this manual.
AUTO LINE FEED	OFF	Disables automatic line feed.
	ON	A line feed (ASCII 10) is appended to every carriage return (ASCII 13) sent to the display. Does not affect transmitted data.
AUTO WRAP-AROUND	ON	Enables auto wrap-around. A carriage return (ASCII 13), line feed (ASCII 10) sequence is sent to the display whenever a character is sent to column 80 (column 40 in the double-sized character mode). Does not affect transmitted data.
	OFF	Disables auto wrap-around.

RS-232-C SERIAL PORT INTERFACE

Introduction

The 1780A uses an RS-232-C bit-serial, asynchronous, data terminal type interface port. The following paragraphs describe the functional and electrical characteristics of the port, the 1780A data buffers, and the RS-232-C cables available from Fluke.

RS-232-C Port Line Characteristics

The line characteristics of the 1780A RS-232-C port are as follows:

1. In output lines, drivers withstand shorts and opens. When functions (the state of things such as the ready lines) are sent, the lines are high when true. When data is sent, the lines are always low when true. In tabular form, the lines are as follows for function and data:

FUNCTION	DATA	SIGNAL VOLTAGE
True	0	+12V
False	1	-12V

2. Input lines cannot be properly driven in the undefined region between -3V and +3V. So don't try to drive the input lines with standard TTL drivers. When functions are received, the lines are high when true. When data is received, the lines are always low when true. In tabular form, the lines are as follows for function, data, and undefined voltage range:

FUNCTION	DATA	SIGNAL VOLTAGE RANGE
True	0	+3V to +25V
False	1	-25V to -3V
Undefined	?	-3V to +3V

3. Load impedance should be 3000 to 7000 Ohms, non-inductive (output lines cannot directly drive relays).

4. Capacitive loading should be less than 2500 pf. This is generally the limiting factor of cable length.

RS-232-C Interface Connector Pin Assignment

Interface connection is made through a 25-pin, D-series, male connector. Pin definitions and descriptions are listed in Table 2-4.

Table 2-4. RS-232-C Interface Connector Pin Assignment

PIN	CIRCUIT	I/O	DESCRIPTION
1	AA	-	Ground (Shield): Connected to logic and chassis ground through a jumper.
2	BA	OUT	Transmitted Data: Outgoing negative-true, serial data.
3	BB	IN	Received Data: Incoming negative-true, serial data.
4	CA	OUT	Request to Send: Asserted positive-true during data transmission.
5	CB	IN	Clear to Send: Must be asserted positive with respect to Signal Return (pin 7) for data transmission to proceed. Setting this line false (negative) stops transmission on a character boundary.
6	CC	IN	Data Set Ready: This command is ignored.
7	AB	-	Signal Return: Zero reference point for data and status lines. The 1780A references this point to logic and to chassis ground.
11	-	OUT	Secondary Request to Send: Asserted positive with respect to Signal Return (pin 7) when the 1780A is ready, and its input buffer contains less than 32 characters. Set false (negative) when the input buffer fills to 32 or more characters (maximum 48). See the 1780A Input and Output Data Buffer material later in this section.
19	SCA	OUT	Secondary Request to Send: Same function as Pin 11, but not physically connected to pin 11.
20	CD	OUT	Data Terminal Ready: Supplied always positive-true through a 100 Ohm pullup resistor to +12V dc.

1780A Input and Output Data Buffers

The 1780A Input and Output Data Buffers hold 48 characters each. The buffer protocol is as follows:

1. Input Buffer

   a. When filled to 32 characters, an X-OFF (Transmit-Off) character is transmitted and the SCA line (pins 11 and 19 of the port) is set false. The X-OFF character is an ASCII 19 or a CTRL/S.

   b. When filled to 48 characters (overflow), data reception is stopped. Subsequent input characters are lost. The input buffer can fill to overflow at 9,600 baud.

   c. When drained to 16 characters, an X-ON (Transmit-On) character is transmitted, the SCA line is set true, and data reception is resumed. The X-ON character is an ASCII 17, CTRL/Q.

2. Output Buffer: When the character sequence <ESC> [9 z is received, the Touch-Sensitive Overlay buffer contents are cleared to zero.

NOTES

If the Touch-Sense Reporting uses any multiple character format, an overflowed output buffer may contain an incomplete Touch-Sense Report as its last entry.

When the polling mode is enabled, the output buffer never contains more than one Touch-Sense Report. Refer to Section 4 for details.

1. If the Clear To Send line (Pin 5 of the RS-232-C connector) is not true, then all 1780A transmission stops. After transmission stops, the output buffer can be filled to 48 characters (overflow), then additional characters are dropped.

2. When the 1780A is placed in the Polling Mode (see Section 4), Touch-Sensitive Overlay outputs are taken one at a time. Additional Touch-Sensitive Overlay inputs are lost until the last input is polled. This does not affect entries via the optional 1780A-001 Keyboard Interface.

INTRODUCTION

The information in this section describes the physical features of the 1780A and provides the operator with notes about the Touch-Sensitive Overlay.

FRONT AND REAR PANEL FEATURES

Figure 3-1 shows the location of all front and rear panel features. Table 3-1 lists these features and describes the function of each feature.

Table 3-1. 1780A Front and Rear Panel Features

ITEM NO.	NAME	FUNCTION
1	Touch-Sensitive Overlay	Low profile high resolution character display with a Touch-Sensitive Overlay. The Touch-Sensitive Overlay recognizes 60 separate touch-sensitive areas.
2	INTENSITY Control	Rotary control used to adjust display intensity.
3	POWER Switch	Two position switch that connects and disconnects line power. Position 1 is on and position 0 is off.
4	Line Power Receptacle/ Voltage Selection PCB/ Main Power Fuse	A single unit that contains the receptacle for the line power cord, a removable circuit board that selects the 1780A operating voltage (100, 120, 220, or 240V ac), and the main power fuse.
5	Covered Hole	Mounting hole for the optional 1780A-001 Keyboard Interface Connector (see Section 8).
6	RS-232-C Serial Port	Standard RS-232-C serial interface data terminal port.

Table 3-1. 1780A Front and Rear Panel Features (cont)

ITEM NO.	NAME	FUNCTION
7	BAUD RATE Switch	Nine position rotary switch. If the TEST MODE FUNCTION switch is at the OFF position, this switch selects the RS-232-C interface serial port baud rate. If the TEST MODE FUNCTION switch is at the ON position, this switch selects which self test is run (see Section 6).
8	ACTIVITY LED	Red LED that blinks while the 1780A is operating or turns on steadily if the power-on self-test fails. (See Section 6 for troubleshooting information.)
9	FUNCTION Switches*	Seven, 2-position switches that determine 1780A operating parameters.
	PARITY	Enables or disables parity check and generation.
	PARITY SENSE	Selects odd or even parity check.
	STOP BITS	Selects one or two stop bits as minimum spacing between transmitted characters.
	DATA BITS	Selects seven or eight data bits.
	TEST MODE	Enables or disables the Test Mode. (See Section 6 for details.)
	AUTO LINE FEED	Enables or disables display auto line feed.
	AUTO WRAP-AROUND	Enables or disables display auto wrap-around

* The FUNCTION switches are described in more detail in Section 2.

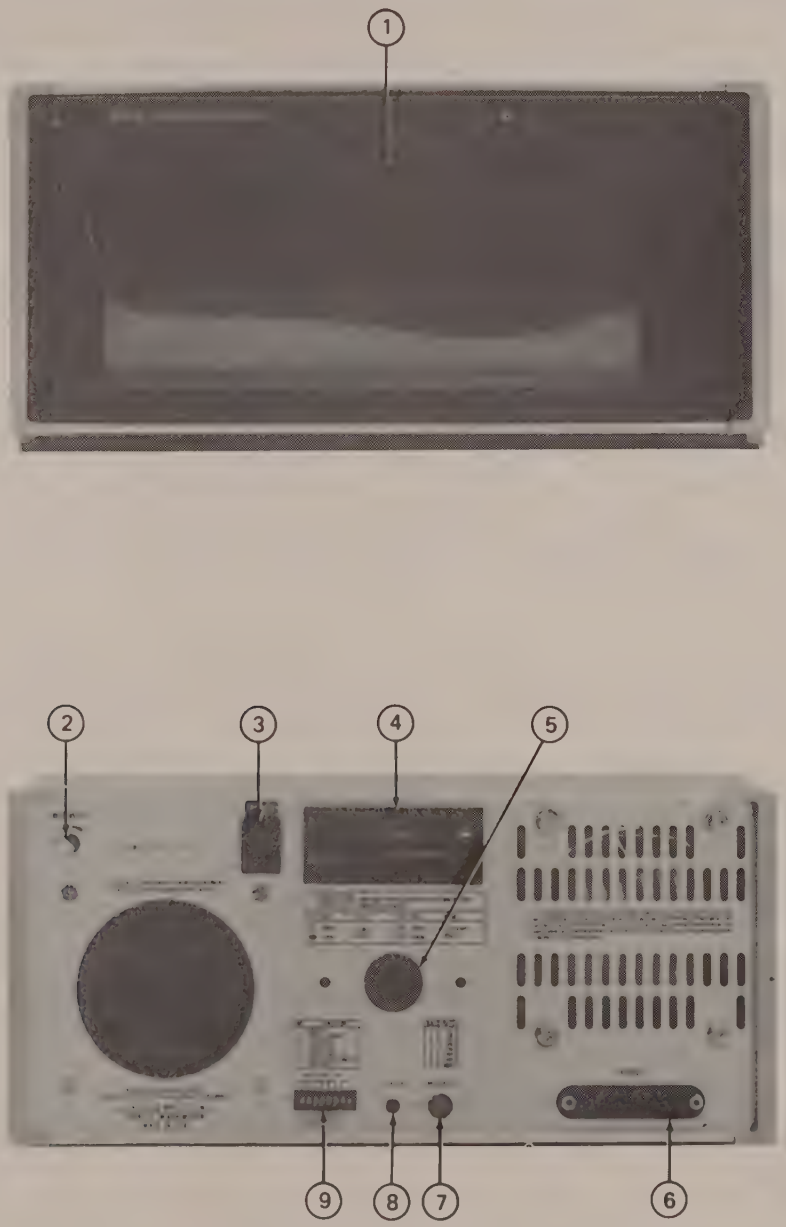

Figure 3-1. 1780A Front and Rear Panel Features

TOUCH-SENSITIVE OVERLAY OPERATING NOTES

Introduction

The touch-sensitive panel overlaying the face of the display is constructed of two layers of transparent flexible material. This panel is called the Touch-Sensitive Overlay. The two surfaces of this material that face together are slightly metalized for conductivity, and divided into horizontal and vertical bands. The result is a resistive switch contact matrix that responds to a light touch. Decoding circuitry separately identifies each area that is sensitive to touch. These areas are called Touch-Sense Keys. The size of each key is three double-size characters or 12 normal-sized characters (chosen to approximate the size of a finger-tip). These keys are arranged in 6 rows of 10 each, numbered from upper left; 1 through 60. The faint lines on the overlay are the isolation lines that form the boundaries of each Touch-Sense Key.

Continuous Touch-Sense Key Entries

Usually, continuous touch pressure on the display is interpreted as a single entry. However, the host computer can enable the auto-repeat mode by sending a command to the 1780A. In the auto-repeat mode, a continuous pressure is interpreted, after an initial pause of about one-half a second, as series of repetitive entries (about 15 entries per second).

Touch-Sense Key Rollover

Touch-Sense Keys have no provision for rollover. Key rollover allows a system to recognize when a second (or more) key has been pressed before pressure is removed from the first key. Since the 1780A Touch-Sense Keys do not have defined edges like the keys on a mechanical keyboard, key rollover could cause erroneous multiple entries. The 1780A is designed to recognize the first, and only the first, Touch-sense Key that is pressed.

Display and Touch-Sensitive Overlay Character Layout

The character layout of the 1780A display and the Touch-Sense Key areas of the TSO are supplied on display worksheets to aid design of displays that effectively use the Touch-Sense Keys. A picture of the display worksheet is shown in Section 4. Note that the touch-sensitive areas are shown overlaying both single and double-size display locations with the corresponding Touch-Sense Key number in the lower right corner of each block. The display worksheets are available in pads of 50 as Fluke part number 533547.

Viewing Errors

As Figure 3-2 shows, the Touch-Sense Keys and the targets displayed on the inside surface of the CRT are a short distance apart (about 1.2 cm). This means that if you view the display from too great an angle, you may miss the target. Make sure you are facing the screen directly when making choices.

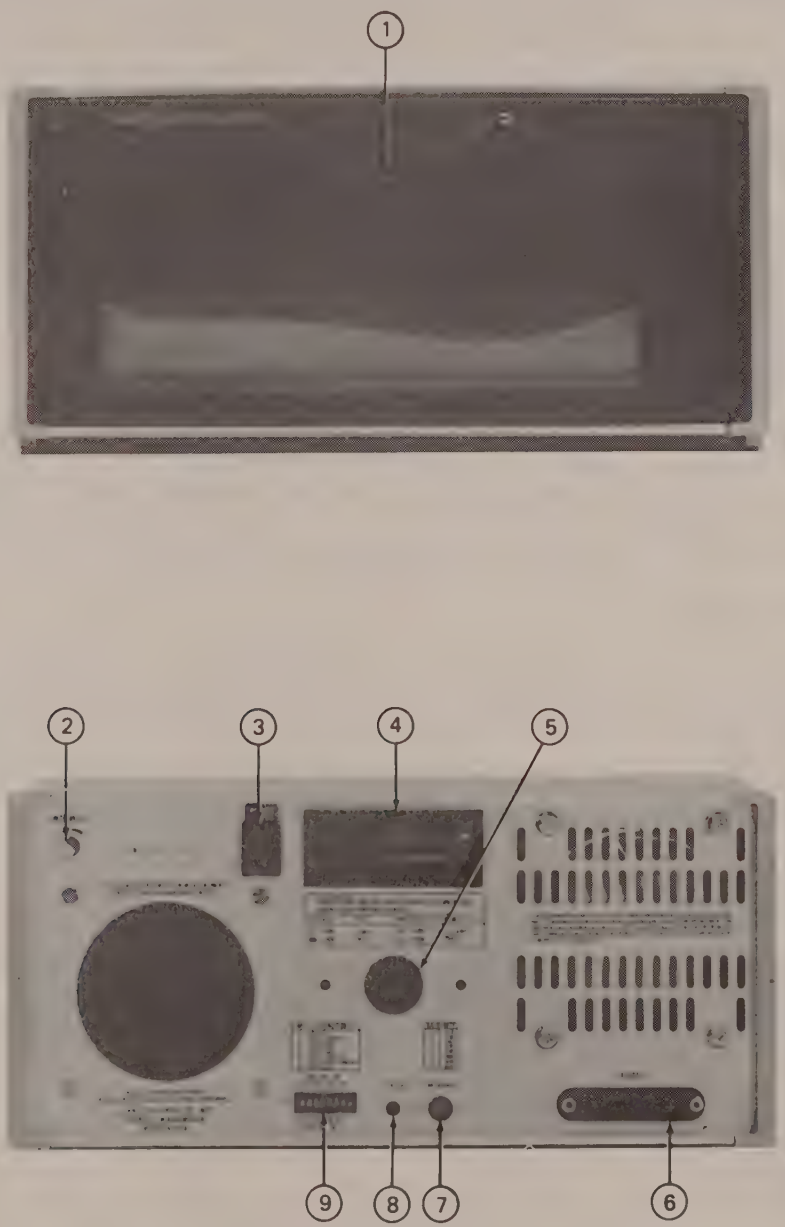

Figure 3-1. 1780A Front and Rear Panel Features

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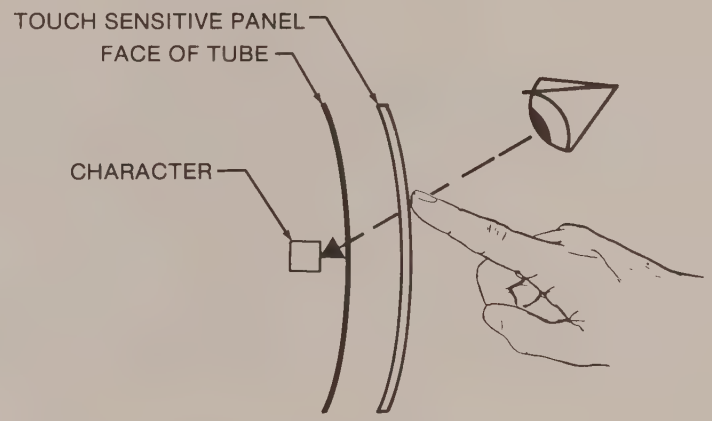


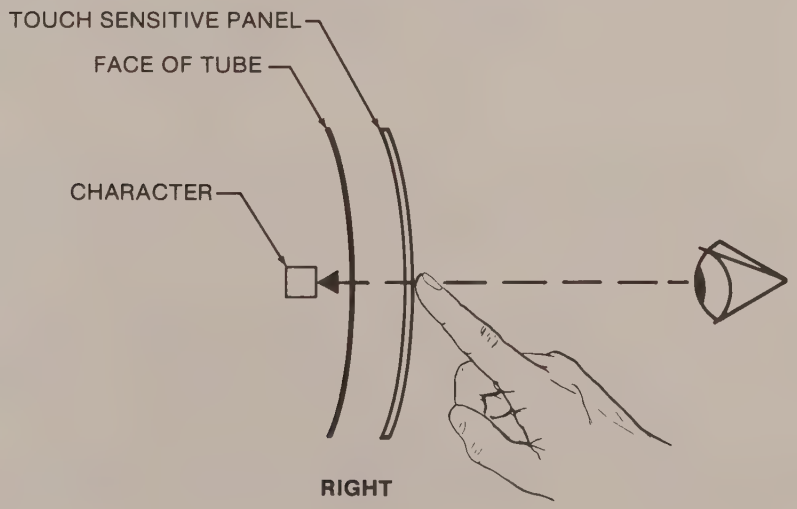


Figure 3-2. Viewing Errors

INTRODUCTION

The information in this section and subsections 4A and 4B helps the programmer create displays on the 1780A and interpret responses from the 1780A Touch-Sensitive Overlay. Included in this section is a discussion of communication between the 1780A and the host computer, and the 1780A interpretation of the ASCII character set.

Subsection 4A describes the ANSI Standard Control Sequences recognized by the 1780A. Subsection 4B shows an example 1780A display and lists the program that created the display. Section 8 provides the information necessary for the programmer to interpret responses from devices connected to the 1780A via the optional keyboard interface.

COMMUNICATION BETWEEN THE 1780A AND THE OPERATOR

Introduction

The 1780A may display information or may ask the operator to make a choice. The operator reads the display and responds by pressing the appropriate area on the Touch-Sensitive Overlay. The following paragraphs describe each of these 1780A features in detail.

1780A Display

As Figure 4-1 shows, the 1780A can display 16 lines with 80 normal-sized characters each or eight lines of 40 double-sized characters each. All characters on a particular screen must be either normal-sized or double-sized.

Display character patterns are generated from a character set EPROM. The standard character set EPROM contains the 128 characters listed in the ASCII table at the end of this section. Appendix A describes how to design your own set of 128 or 256 graphics or language characters.

Four character enhancements are available: high intensity, blinking, underlining, and reverse video. The enhancements can be used in any combination.

The cursor can be selected to be a steady or blinking video block or can be removed from the screen.

1780A Touch-Sensitive Overlay

As Figure 4-1 shows, the 60 touch-sense areas are arranged in six rows of ten keys. The 1780A treats the touch-sensitive areas like keys on a keyboard. Each key is the size of three double-sized characters or 12 normal-sized characters (approximately the size of a fingertip). When a key is touched, the 1780A sends the key number to the host computer. Touch-Sense Reporting Formats are described later in this section.

The host computer can instruct the 1780A to recognize a continued pressure on one area as either a single entry or as repetitive entries (at a rate of about 15 entries per second). The Touch-Sense Keys do not have key rollover. That is, when two or more keys are pressed at the same time, the 1780A recognizes only the first key touched.

Display targets behind these keys are generated by a program in the host computer. For example, if key 51 were to be a press-to-continue key, the host computer programmer would create a display behind key 51 that asked the operator to press to continue. The host computer would then need to recognize the Touch-Sense Report that corresponds to key 51. Section 4A provides information on touch-sense programming.

Optional Keyboard Interface

Devices connected to the 1780A via the optional keyboard interface can cause the 1780A to generate standard ASCII characters, or to act like an extension of the Touch-Sensitive Overlay. The keyboard interface is described in detail in Section 8.

COMMUNICATION BETWEEN THE 1780A AND THE HOST COMPUTER

Introduction

Since the 1780A acts like two separate devices, a display and a data entry device, there are two types of communication between the 1780A and the host computer: characters and command strings from the host computer that define 1780A displays and responses from the 1780A Touch-Sensitive Overlay or devices connected to the 1780A via the optional keyboard interface.

All communications between the 1780A and the host computer are ASCII characters or ASCII-coded character strings (ANSI escape sequences) transmitted through the RS-232-C serial interface port.

The following paragraphs provide an overview of 1780A inputs and outputs and describe the 1780A Input and Output Buffers. ASCII characters and control codes are described at the end of this section. The ANSI Escape Sequences are described in Section 4A.

1780A Inputs

All 1780A inputs are transmitted through the RS-232-C serial interface as ASCII characters. These characters appear on the 1780A display or control the 1780A displays and formats.

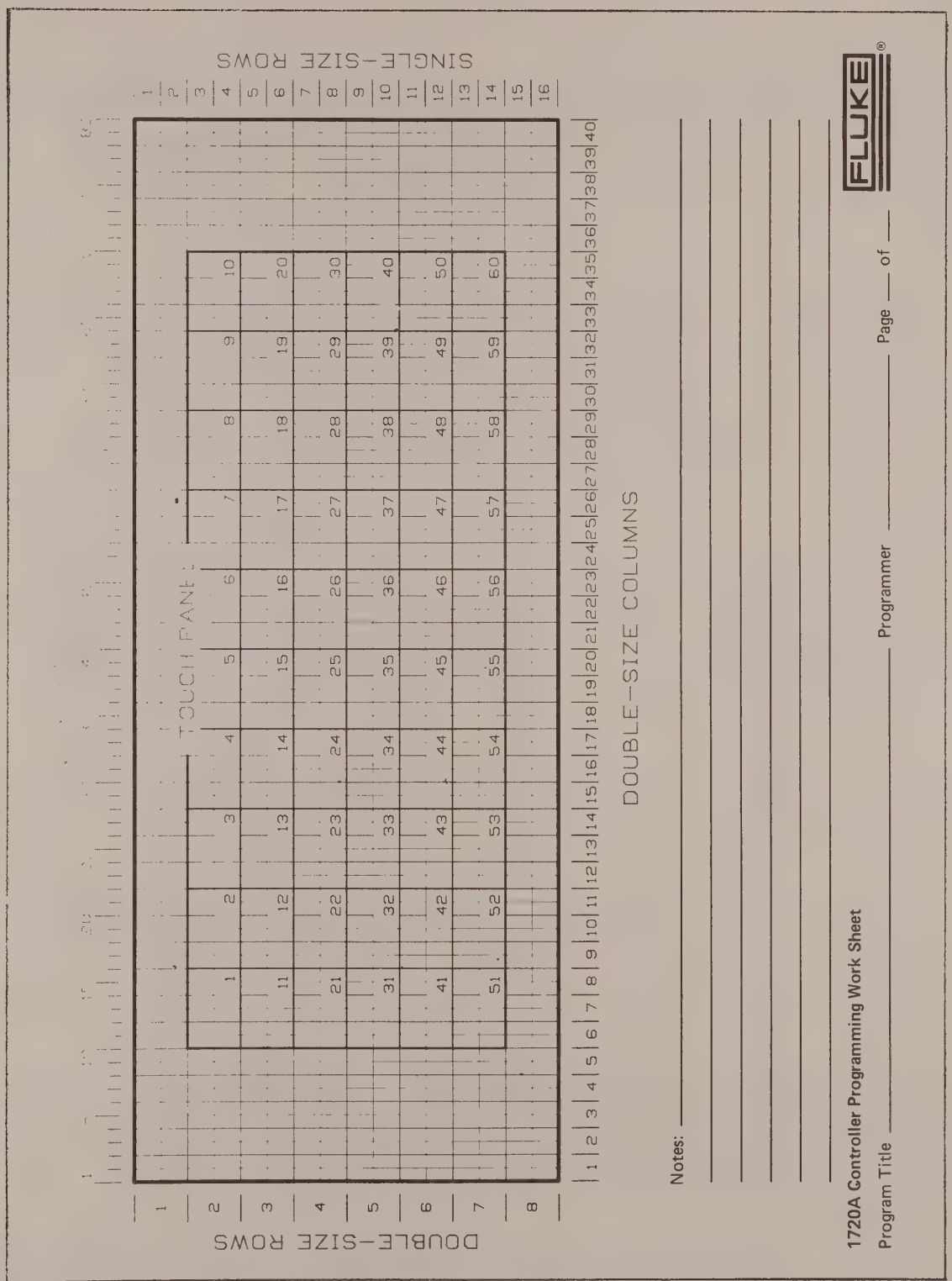


Figure 4-1. Display Worksheet

1780A Outputs

Touch-Sense Reports are usually a 7-character ASCII string of the form <ESC> [nnn z <CR>, where nnn is the key number given as a numeric zero-filled string. The host computer, however, can redefine or eliminate the flag characters (<ESC> and [) and terminator characters (z and <CR>) and can instruct the 1780A to report the key number as a single-byte binary number.

1780A Input/Output Buffers

The 1780A has a 48 character input buffer and a 48 character output buffer. Characters sent to the 1780A are stored in the input buffer until they are displayed. When the buffer is filled to 32 characters, the 1780A sets pin 19 (Secondary Request to Send) false. If the host computer does not automatically stop transmission, it should be programmed to respond to the <X-OFF> character. The 1780A sends an <X-ON> character (ASCII 17) and sets lines 11 and 19 true when the input buffer is drained to 16 characters.

ASCII Standard Codes

The ASCII codes used to control and format displays on the 1780A conform to the ASCII Standard 3.4-1968. Table 4-1 lists the ASCII standard codes and the corresponding 1780A display results. For example, when the host computer sends an ASCII <109>, the 1780A displays m. As the table shows, 13 of the ASCII control codes are intercepted for display control. These 13 codes are not displayed.

All of the ASCII control codes except <ESC> (ASCII 27) cause a specific action. For example, an ASCII <7> (<BEL>) is the code for a bell and causes the 1780A to sound an audible beep. Table 4-2 lists all of the ASCII control codes and defines the action caused by each code except for <ESC>.

<ESC> introduces ANSI control sequences. The ANSI control sequences act as an extension of the ASCII control codes in that they allow additional control of the 1780A displays and format. The ANSI control sequences are defined in Section 4A.

ANSI Standard Control Sequences

The 1780A recognizes ANSI Standard Control Sequences dealing with terminal interfaces. Since the ANSI Standard has no codes for Touch-Sensitive Overlays, Fluke has defined a legitimate subset of the ANSI Standard control codes for the Touch-Sensitive Overlay. All ANSI Standard Control Sequences are described in Section 4A.

Table 4-1. 1780A Display Response

CODE			1780A	CODE			1780A
DECIMAL	HEXADECIMAL	OCTAL	DISPLAY	DECIMAL	HEXADECIMAL	OCTAL	DISPLAY
0	0	0	NUL*	32	20	40	(space)
1	1	1		33	21	41	!
2	2	2		34	22	42	"
3	3	3		35	23	43	#
4	4	4		36	24	44	$
5	5	5		37	25	45	%
6	6	6		38	26	46	&
7	7	7	BEL *	39	27	47	'
8	8	10	BS *	40	28	50	(
9	9	11	HT *	41	29	51	)
10	A	12	LF *	42	2A	52	*
11	B	13	VT *	43	2B	53	+
12	C	14	FF *	44	2C	54	,
13	D	15	CR *	45	2D	55	-
14	E	16	SO *	46	2E	56	.
15	F	17	SI *	47	2F	57	/
16	10	20		48	30	60	0
17	11	21	**	49	31	61	1
18	12	22		50	32	62	2
19	13	23	**	51	33	63	3
20	14	24		52	34	64	4
21	15	25	o	53	35	65	5
22	16	26		54	36	66	6
23	17	27		55	37	67	7
24	18	30		56	38	70	8
25	19	31		57	39	71	9
26	1A	32		58	3A	72	:
27	1B	33	ESC *	59	3B	73	;
28	1C	34		60	3C	74	<
29	1D	35		61	3D	75	=
30	1E	36		62	3E	76	>
31	1F	37		63	3F	77	?

* These ASCII control codes are not displayed.
** Not used.

Table 4-1. 1780A Display Response (cont)

CODE			1780A	CODE			1780A
DECIMAL	HEXADECIMAL	OCTAL	DISPLAY	DECIMAL	HEXADECIMAL	OCTAL	DISPLAY
64	40	100	@	96	60	140	
65	41	101	A	97	61	141	a
66	42	102	B	98	62	142	b
67	43	103	C	99	63	143	c
68	44	104	D	100	64	144	d
69	45	105	E	101	65	145	e
70	46	106	F	102	66	146	f
71	47	107	G	103	67	147	g
72	48	110	H	104	68	150	h
73	49	111	I	105	69	151	i
74	4A	112	J	106	6A	152	j
75	4B	113	K	107	6B	153	k
76	4C	114	L	108	6C	154	l
77	4D	115	M	109	6D	155	m
78	4E	116	N	110	6E	156	n
79	4F	117	O	111	6F	157	o
80	50	120	P	112	70	160	p
81	51	121	Q	113	71	161	q
82	52	122	R	114	72	162	r
83	53	123	S	115	73	163	s
84	54	124	T	116	74	164	t
85	55	125	U	117	75	165	u
86	56	126	V	118	76	166	v
87	57	127	W	119	77	167	w
88	58	130	X	120	78	170	x
89	59	131	Y	121	79	171	y
90	5A	132	Z	122	7A	172	z
91	5B	133	[	123	7B	173	{
92	5C	134	\	124	7C	174	|
93	5D	135	]	125	7D	175	}
94	5E	136	^	126	7E	176	
95	5F	137	_	127	7F	177	

Table 4-2. ASCII Control Codes

ASCII CODE	ASCII NAME	CTRL/CODE	DESCRIPTION
0	NUL	--	Null. No action.
7	BEL	CTRL/G	Bell code. Sounds beeper.
8	BS	CTRL/H	Backspace.
9	HT	CTRL/I	Horizontal tab*.
10	LF	CTRL/J	Line Feed.
11	VT	CTRL/K	Vertical tab (same as LF).
12	FF	CTRL/L	Form feed (same as LF).
13	CR	CTRL/M	Carriage return.
14	SO	CTRL/N	Shift out to alternate characters.
15	SI	CTRL/O	Shift in to standard characters.
24	CAN**	CTRL/X	Cancel an ANSI control sequence.
26	SUB**	CTRL/Z	Substitute (same as CAN).
27	ESC	--	Escape. Introduces an ANSI control sequence.

* Horizontal tabs are 8 columns apart.
** CAN and SUB are intercepted only when they are part of an ANSI control sequence.

INTRODUCTION

The information in this subsection describes the ANSI standard control sequences recognized by the 1780A. These sequences of ASCII characters are an applicable subset of ANSI Standard X3.64-1977 with adaptations for Touch-Sense Overlay control and response.

- Each control sequence begins with <ESC> (ASCII <27>).
- Each control sequence is terminated by an alpha character that identifies the category of control action.
- When required, numeric parameters (for example, how far to move or how much to erase) precede the terminator.
    1. Leading zeros in numeric parameters are discarded to allow maximum programming flexibility. This means that 005 is the same as 5.
    2. Multiple numeric parameters are separated by a semicolon. The last numeric parameter should NOT be followed by a semicolon.
    3. Except for scrolling commands, all sequences include left-square bracket character (ASCII <91>) following <ESC>.
- For example, the following sequence moves the cursor to line 3, column 29:

    <ESC> [3 ; 2 9 H

- An unrecognized sequence results in the unrecognized parameter(s) and terminator alpha character being displayed. This leaves the 1780A to act upon the next characters received that complete a recognizable sequence. (The <ESC> [is saved).

The following paragraphs describe each escape sequence recognized by the 1780A. All of the escape sequences and their subsequent control actions are summarized in the ANSI Standard Control Sequence Summary Table at the end of this section.

ACTIVE POSITION

Since the cursor does not need to appear on the display, we have used the term "active position" in this section to indicate the position at which the cursor would be displayed.

CURSOR TYPE SELECTION -- <ESC> [n x

Upon receipt of the cursor type selection sequence, the 1780A changes the displayed cursor to the type indicated by the parameter n. The cursor type selection sequences are Fluke-defined.

- The parameter n can be 0, 1, 2.

  1. If n = 0, the cursor is a blinking reverse-video block. This is the default value.

  2. If n = 1, the cursor is a steady reverse-video block.

  3. If n = 2, the cursor is suppressed.

  4. If n is deleted, the 1780A substitutes n = 0.

- The cursor remains at this type until a different type of cursor is selected or until a power on reset is executed.

- EXAMPLES:

  1. The following sequence suppresses the cursor from the display:

     <ESC> [2 x

  2. The following sequence resets the cursor to a blinking reverse-video block (default cursor):

     <ESC> [x

CURSOR CONTROL SEQUENCES

Introduction

Cursor control sequences move the cursor to any position on the screen and, if requested, scroll the screen. There are seven cursor control sequences:

1. Cursor Up (CUU)

2. Cursor Down (CUD)

3. Cursor Forward (CUF)

4. Cursor Backward (CUB)

5. Cursor Position (CUP)

6. Index (IND)

7. Reverse Index (RI)

8. Next Line (NEL)

The four sequences CUU, CUD, CUF, and CUB move the cursor relative to its active position. The sequence CUP moves the cursor to an absolute screen location. None of these sequences can move the cursor past the top or bottom of the screen, but the sequences IND, RI, and NEL scroll the screen up or down one line when the cursor is on the bottom or top lines, respectively. The NEL sequence moves the cursor from the active position to the extreme left column of the next line down. A cursor control sequence produces immediate results, and does not occupy a display location.

Cursor Up (CUU) -- <ESC> [n A

When the 1780A receives a CUU sequence, the cursor is moved up n lines from the active position without changing columns.

- The CUU sequence will not move the cursor above the top of the screen.
- The default value of n is 1.
- The cursor is moved up one line if n is deleted or if n = 0.
- EXAMPLE:

  The following sequence moves the cursor up three lines in the same column:

  <ESC> [3 A

Cursor Down (CUD) -- <ESC> [n B

When the 1780A receives a CUD sequence, the cursor is moved down n lines from the active position without changing columns.

- The CUD sequence will not move the cursor below the bottom of the screen.
- The default value of n is 1.
- The cursor is moved down one line if n is deleted or if n = 0.

- EXAMPLES:

  Any of the following sequences move the cursor down one line in the same column:

  <ESC> [B
  <ESC> [0 B
  <ESC> [1 B
  <ESC> [0 1 B

Cursor Forward (CUF) -- <ESC> [n C

When the 1780A receives a CUF sequence, the cursor is moved n columns to the right from the active position without changing lines.

- The CUF sequence will not move the cursor beyond the right margin.
- The default value of n is 1.
- The cursor is moved right one column if n is deleted or n = 0.
- EXAMPLE:

  The following sequence moves the cursor twelve columns to the right in the same line:

  <ESC> [0 1 2 C

Cursor Backward (CUB) -- <ESC> [n D

When the 1780A receives a CUB sequence, the cursor is moved n columns to the left from the active position without changing lines.

- The CUB sequence will not move the cursor beyond the left margin.
- The default value of n is 1.
- The cursor is moved left one column if n is deleted or if n = 0.
- EXAMPLES:

  1. The following sequence moves the cursor left one column in the same line:

     <ESC> [D

  2. The following sequence moves the cursor to the left edge of the display:

     <ESC> [9 9 D

Cursor Position (CUP) -- <ESC> [l ; c H

When the 1780A receives a CUP sequence, the cursor is moved directly to line l and column c. The position l;c is an absolute value related to the screen instead of the active position of the cursor.

- Line 1 is the top line.
- Column 1 is the leftmost column.
- When l or c is either deleted or zero, the 1780A substitutes a 1.
- Position 1,1 is the upper left hand corner of the display. This is the home position.
- EXAMPLES:

  1. Any of the following sequences move the cursor to the home position:

     <ESC> [; H
     <ESC> [0 ; 0 H
     <ESC> [1 ; 1 H
     <ESC> [01 ; H

  2. The following sequence moves the cursor to line 4, column 32:

     <ESC> [0 0 4 ; 3 2 H

Index (IND) -- <ESC> D

When the 1780A receives an IND sequence, the cursor is moved down one line from the active position without changing columns. If the active position is at the bottom of the screen, the screen is scrolled up one line.

Reverse Index (RI) -- <ESC> M

When the 1780A receives a RI sequence, the cursor is moved up one line from the active position without changing columns. If the active position is at the top of the screen, the screen is scrolled down one line.

Next Line (NEL) -- <ESC> E

When the 1780A receives a NEL sequence, the cursor is moved to the leftmost column and down one line from the active position. If the active position is at the bottom of the screen, the screen is scrolled up one line.

CURSOR POSITION REPORTING

The two cursor position reporting sequences work as a pair. The Device Status Request (DSR) sequence is sent from the host computer to request the current active position from the 1780A. The Cursor Position Report (CPR) sequence is the reply from the 1780A to the host computer.

- The DSR sequence is as follows:

  <ESC> [6 n

  NOTE

  In this sequence, n is the terminating alpha character and does not represent a number.

- The CPR sequence format is as follows:

  <ESC> [l ; c R

  Where:
  l = line number
  c = column number
  Line and column numbers are reported as one or two digit numeric strings with left zeros suppressed.

- EXAMPLE:

  The cursor is at line 8 and column 12. After receiving <ESC> [6 n from the host computer, the 1780A would report the active position in the following format:

  <ESC> [8 ; 1 2 R

MODE SELECTION -- <ESC> [n ; n ; n; ... p

Introduction

The mode selection are Fluke-defined adaptations of the ANSI standard that allow the user to select any of the modes shown in Table 4A-1. Mode(s) selected depend upon the value(s) of the parameter(s) n. Mode selection does not occupy a character position on the display.

Mode selection may be intermixed with other display control commands, but the sequence can sometimes make a difference. For example, if the user plans to both position the cursor and to change the displayed character size, the host computer program should be written to first select the character size and then to position the cursor. This sequence is necessary because the Character Size Mode Selection Escape Sequences move the cursor to the upper left corner of the display.

Mode selection sequences can be mixed. For example, the following sequence would select both the Double-sized Character and Standard Graphics Modes:

<ESC> [1 ; 3 p

The following paragraphs provide additional information about the modes.

Character Size Mode -- <ESC> [n ; p

The character size mode instructs the 1780A to adjust its scanning rate so that all characters are displayed either normal-size or double-size.

- If n is deleted or if n = 0, normal-sized characters are displayed. This is the default condition. Display capacity with normal-size characters is 16 lines of 80 characters each.
- If n = 1, double-sized characters are displayed. Display capacity with double-sized characters is 8 lines of 40 characters each.
- When one character size is enabled, the other size is disabled. The two character sizes cannot be intermixed on the same display.
- Character size commands clear the screen, set the entire screen to the selected character size, and move the cursor to the upper left (home) position.
- EXAMPLES:

  1. The following sequence selects a double-size character display:

     <ESC> [1 p

  2. Either of the following sequences selects a normal-sized character display (default condition):

     <ESC> [p
     <ESC> [0 p

Standard Graphics Mode -- <ESC> [n p

The Standard Graphics Mode substitutes graphics characters for the numbers 0 through 9, and the character : (colon).

- Table 4A-2 shows the Standard Graphics Mode characters.
- These graphics characters are identical to the graphics characters for the Fluke 1720A Instrument Controller.

Table 4A-1. Mode Selection Escape Sequences

MODE	PARAMETER (n)	ACTION
Character Size Mode	0	Enable Normal Size*
	1	Enable Double Size
Standard Graphics Mode	2	Disable*
	3	Enable
Auto Line Feed	6	Enable**
	7	Disable**
Auto Wrap-Around	10	Enable**
	11	Disable**
Auto Beep Mode	12	Enable
	13	Disable*
Auto Repeat Mode	14	Enable
	15	Disable*
Polling Mode	16	Enable
	17	Disable*

* Default condition.
** Default condition depends upon the position of the appropriate FUNCTION switch.

- EXAMPLES:

  1. The following sequence selects the Standard Graphics Mode:

     <ESC> [3 p

  2. The following sequence returns the 1780A to its default mode (Standard Graphics Mode disabled):

     <ESC> [2 p

  3. The following sequence selects double-sized character display and the Standard Graphics Mode. Note that the mode selection commands can be combined.

     <ESC> [1 ; 3 p

Auto Line Feed Mode -- <ESC> [n p

The Auto Line Feed Mode appends a line feed character (ASCII 10) to all carriage returns such as when the RETURN key is pressed on a Y1720 Programmer Keyboard.

- Send <ESC> [6 p to enable the Auto Line Feed Mode.
- Send <ESC> [7 p to disable the Auto Line Feed Mode.
- The AUTO LINE FEED FUNCTION switch sets the default condition.

Auto Wrap-Around Mode -- <ESC> [n p

The Auto Wrap-Around Mode sends a carriage return and a line feed sequence to the display whenever an attempt is made to display text beyond column 80 (column 40 in the double-sized character mode).

- Send <ESC> [10 p to enable the Auto-Wrap-Around Mode.
- Send <ESC> [11 p to disable the Auto Wrap-Around Mode.
- The AUTO WRAP-AROUND FUNCTION switch sets the default condition.

Auto-Beep Mode -- <ESC> [n p

The Auto-Beep Mode sounds the 1780A audible beeper whenever the Touch-Sensitive Overlay is pressed.

- Send <ESC> [1 2 p to enable the Auto-Beep Mode.
- Send <ESC> [1 3 p to disable the Auto-Beep Mode. This is the default condition.

Auto-Repeat Mode -- <ESC> [n p

The Auto-Repeat Mode repeats any Touch-Sense Key which is constantly pressed at a rate of about 15 entries per second after an initial pause of about one-half a second. The selectable Auto-Repeat Mode works only for the Touch-Sensitive Overlay. The Keyboard Interface, Option 1780A-001, always auto-repeats.

- Send <ESC> [1 4 p to enable the Auto-Repeat Mode.
- Send <ESC> [1 5 p to disable the Auto-Repeat Mode. This is the default condition.

Table 4A-2. Standard Graphics Mode Characters

INPUT CHARACTER	DISPLAY RESULT	DESCRIPTION
0		Top Right Corner
1		Top Left Corner
2		Bottom Right Corner or Left Intersect
3		Bottom Left Corner or Right Intersect
4		Horizontal Line or Top Intersect
5		Left Vertical Line
6		Right Vertical Line
7		Bottom Crossed Line
8		Horizontal Line or Bottom Intersect
9		Vertical Line
:		Top Crossed Line

NOTES:

1. When n = 3, the Standard Graphics Mode is enabled.
2. When n = 2, the Standard Graphics Mode is disabled.

Polling Mode -- <ESC> [n p

The Polling Mode allows the 1780A to accept one and only one Touch-Sense Key input at a time. Subsequent inputs are not accepted by the 1780A until the host computer has accepted the last Touch-Sense Report.

- The Polling Mode prevents data overruns and lost characters when the 1780A is used with a host computer that has a slow I/O (input/output) response.
- Send <ESC> [16 p to the 1780A to enable the Polling Mode.
    1. When the Polling Mode is enabled, send <ESC> [3 z to the 1780A to request that a Touch-Sense Report be sent to the host computer.
    2. If the Auto-Beep Mode is enabled, no beeping occurs until the host computer accepts the last Touch-Sense Report.
- Send <ESC> [17 p to the 1780A to disable the Polling Mode.

CHARACTER ENHANCEMENT -- <ESC> [n ; n ; n ; ... m

Introduction

Character enhancements are used to draw attention to a portion of a display or to select an alternate character set. Characters can be enhanced in any combination of four ways: high intensity, underlining, blinking, and reverse video. Table 4A-3 lists the character enhancement sequences.

The enhancement commands occupy one display position and define a display mode for all characters that follow. Overwriting a display location containing an enhancement command deletes the enhancement(s). Each enhancement command cancels all previous enhancements.

Multiple enhancements are combined in the same enhancement command by separating the parameters by semicolons. Do not place a semicolon after the last parameter. A multiple enhancement command occupies only one display position.

Since the refresh scanning rate of the display exceeds the baud rate at which characters are written into the display memory, underlining and reverse image commands momentarily cause the entire remaining display to have underlines or light background until the enhancements-off command is written. This can be avoided by positioning the cursor to place the enhancements-off command, then backing up to place the desired enhancement command before the start of the words to be enhanced. Use the Display Worksheet to determine the cursor positioning. When planning an enhanced display that uses this technique, remember that the cursor spaces forward one place after each enhancement command, just as it does for any other character.

EXAMPLES:

1. The following sequence enhances characters that follow by underlining them:

   <ESC> [4 m

2. The following sequence enhances characters that follow by increasing intensity and by blinking them:

   <ESC> [1 ; 5 m

3. The following sequence, which is the previous example with the semicolon missing, is not recognized:

   <ESC> [1 5 m

4. Either of the following sequences turns off all enhancements (default condition):

   <ESC> [m
   <ESC> [0 m

Table 4A-3. Display Enhancement Sequences

PARAMETER (n)	ENHANCEMENT
none	All enhancements turned off (default condition).
0	All enhancements turned off.
1	Intensity increased.
4	Underlined.
5	Blinking.
7	Reverse video.
8	Select alternate character set.

Select Alternate Character Set -- <ESC> [8 m

When an ASCII character is sent to the 1780A, the standard or alternate character set mode selected determines the character that appears on the display. The standard character set consists of the 128 characters listed in Table 4-1. The alternate character set can be an optional character set or a user-defined extended character set.

- Send <ESC> [8 m to select the alternate character set. This command causes the same action as the SO ASCII control code (ASCII <14>).

  a. Enabling the alternate character set disables the standard character set.

  b. Character enhancements can be combined with the alternate character set selection command.

  c. Alternate character set selection occupies a display position even when character enhancements are not included.

  d. The alternate character set selection command must be displayed to be effective. If it is scrolled off the top of the display, the remaining characters revert to the standard character set.

- Send <ESC> [m or <ESC> [0 m to turn off all enhancements. This returns the 1780A to the standard character set mode.

ERASE DISPLAY (ED) -- <ESC> [n J

When the 1780A receives one of the erase display (ED) commands, it erases that portion of the display defined by the parameter n.

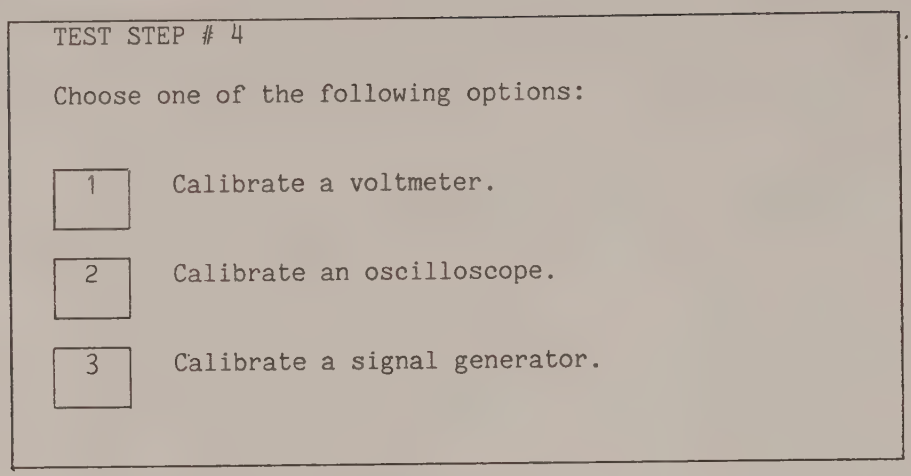
- The ED sequences are defined in Table 4A-4.

- The ED sequence does not occupy a display location.

Table 4A-4. Erase Display Sequences

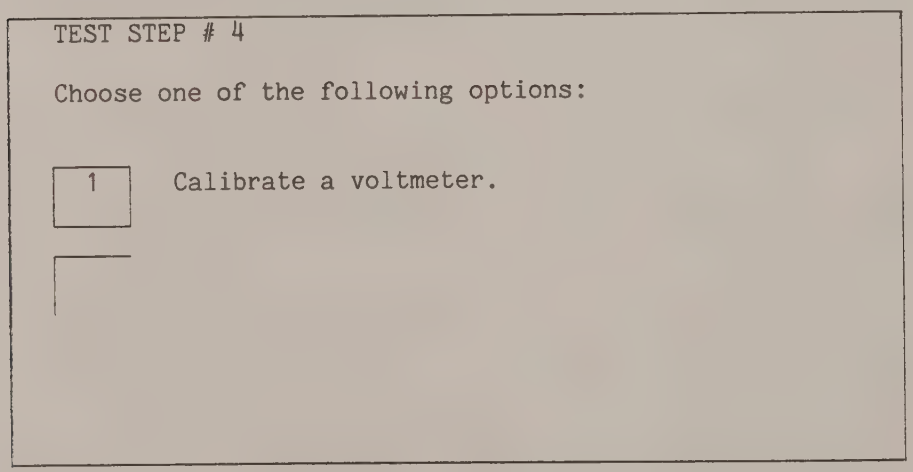
PARAMETER (n)	ACTION
0 or deleted	The display is erased from the active position through the end of the screen, inclusive. This is the default condition.
1	The display is erased from the start of the screen through the active position, inclusive.
2	The entire display is erased.

* EXAMPLES: Assume that before each of the following sequences, the active position is at the number 2 of the following display:



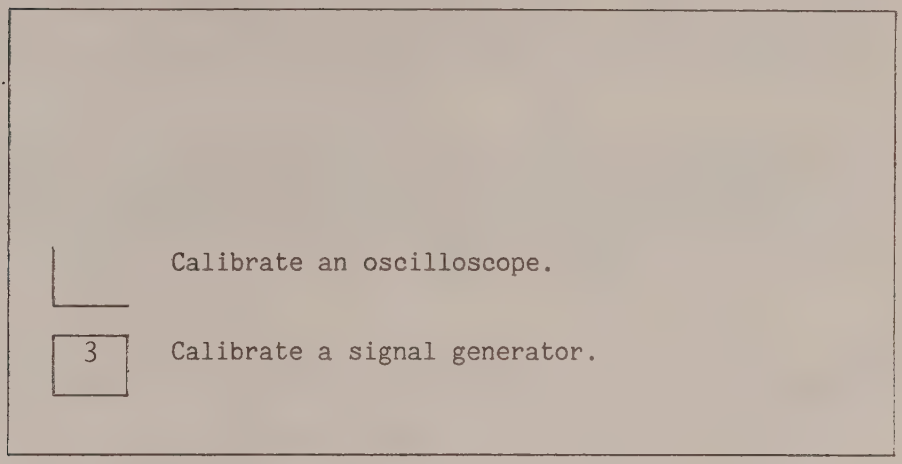
1. The following sequence (default condition) erases the display from the active position through the end of the screen as shown:

   <ESC> [0 J



2. The following sequence erases the display from the start of the screen through the active position, inclusive as shown:

   <ESC> [1 J



3. The following sequence erases the entire screen:

   <ESC> [2 J

ERASE LINE (EL) -- <ESC> [n K

When the 1780A receives one of the erase line (EL) commands, it erases that portion of the line defined by the parameter n.

- Table 4A-5 lists the EL sequences.
- The EL sequence does not occupy a display location.

Table 4A-5. Erase Line Sequences

PARAMETER (n)	ACTION
0 or deleted	The line is erased from the active position through the end of the line, inclusive. This is the default condition.
1	The line is erased from the start of the line through the active position, inclusive.
2	The entire line is erased.

* EXAMPLES: Assume that before each of the following sequences, the active position is at the number 2 in the following display:

```
Your flight will depart from Gate 21 at 11:45.
```

1. The following sequence erases the line from the active position through the end of the line, inclusive, as shown:

   <ESC> [0 K

```
Your flight will depart from Gate
```

2. The following sequence erases the line from the start of the line through the active position as shown:

   <ESC> [1 K

```
                                    1 at 11:45.
```

3. The following sequence erases the entire line:

   <ESC> [2 K

TOUCH-SENSE REPORTING

Introduction

The 1780A Touch-Sense Report has the format [f1] [f2] nnn [t1] [t2] where nnn is the Touch-Sense Key number, [f1] and [f2] are flag characters that precede the key number, and [t1] and [t2] are terminator characters that follow the Touch-Sense Key number.

The 1780A default-format Touch-Sense Report conforms to the ANSI standard command string format. The two flag characters are <ESC> and [. The Touch-Sense Key number is reported as a 3-digit, zero-filled ASCII numeric string (001 through 060). The two terminator characters are z and <CR>. For example, pressing Touch-Sense Key 33 would result in the sequence <ESC> [0 3 3 z <CR>. The carriage return line terminator <CR> is included for compatibility with the many systems (such as the Fluke 1720A) that require a line-oriented input.

To allow maximum flexibility in making Touch-Sense Reporting compatible with various system requirements, the 1780A accepts input commands that redefine or eliminate each flag and terminator character. In addition, the format of the Touch-Sense Key number can be redefined to be a single 8-bit binary byte in place of the ASCII numeric sequence.

Touch-Sense Report Flag Characters

Flag characters are defined by sending the 1780A the following command string:

<ESC> [<f1> ; <f2> v

- The default values of <f1> and <f2> are <ESC> and [, respectively.
- <f1> and <f2> can be set to any ASCII character or control code.
- <f1> and <f2> are ASCII numeric strings representing the decimal value of the desired character code. For example, <ESC> [4 2 v selects an asterisk (*) as a single flag character.
- Leading zeros (zeros to the left of digits) in <f1> and <f2> are ignored. For example, both of these sequences select the flag characters <VT> and %:

  <ESC> [0 1 1 ; 0 3 7 v
  <ESC> [1 1 ; 3 7 v

- Either one or both flag characters can be deleted from the Touch-Sense Report:

  1. The following sequence defines a Touch-Sense Format with only one flag character:

     <ESC> [<f1> v

  2. The following sequence defines a Touch-Sense Format with no flag characters:

     <ESC> [v

Touch-Sense Report Terminator Characters

Terminator characters are defined by sending the 1780A the following sequence:

<ESC> [<t1> ; <t2> w

- The default values of <t1> and <t2> are z and <CR>, respectively.
- <t1> and <t2> can be set to any ASCII character or control code.
- <t1> and <t2> are ASCII numeric strings representing the decimal value of the desired character code. For example, the following sequence selects the terminator characters n and <LF>:

  <ESC> [1 1 0 ; 1 0 w

- Leading zeros (zeros to the left of digits) in <t1> and <t2> are ignored. For example, both of these sequences select the flag characters % and <LF>:

  <ESC> [0 3 7 ; 0 1 0 w
  <ESC> [3 7 ; 1 0 w

- Either one or both terminator characters can be deleted from the Touch-Sense Format:

  1. The following sequence defines a Touch-Sense Format with one terminator character:

     <ESC> [<t1> w

  2. The following sequence defines a Touch-Sense Format with no terminator characters: <ESC> [w

Touch-Sense Key Numbers

The Touch-Sense Key number is usually reported as a 3-digit ASCII numeric string, but the number can be reported in binary format as a single byte.

- Send one of the following sequences to the 1780A to select the ASCII Touch-Sense Report Mode:

  <ESC> [z
  <ESC> [0 z
  <ESC> [1 z

  1. This is the default mode.

  2. In this mode, the Touch-Sense Key number is reported as a 3-digit ASCII numeric string from 001 (upper left corner) through 060 (lower right corner).

The 1780A default-format Touch-Sense Report conforms to the ANSI standard command string format. The two flag characters are <ESC> and [. The Touch-Sense Key number is reported as a 3-digit, zero-filled ASCII numeric string (001 through 060). The two terminator characters are z and <CR>. For example, pressing Touch-Sense Key 33 would result in the sequence <ESC> [0 3 3 z <CR>. The carriage return line terminator <CR> is included for compatibility with the many systems (such as the Fluke 1720A) that require a line-oriented input.

To allow maximum flexibility in making Touch-Sense Reporting compatible with various system requirements, the 1780A accepts input commands that redefine or eliminate each flag and terminator character. In addition, the format of the Touch-Sense Key number can be redefined to be a single 8-bit binary byte in place of the ASCII numeric sequence.

Touch-Sense Report Flag Characters

Flag characters are defined by sending the 1780A the following command string:

<ESC> [<f1> ; <f2> v

- The default values of <f1> and <f2> are <ESC> and [, respectively.
- <f1> and <f2> can be set to any ASCII character or control code.
- <f1> and <f2> are ASCII numeric strings representing the decimal value of the desired character code. For example, <ESC> [4 2 v selects an asterisk (*) as a single flag character.
- Leading zeros (zeros to the left of digits) in <f1> and <f2> are ignored. For example, both of these sequences select the flag characters <VT> and %:

  <ESC> [0 1 1 ; 0 3 7 v
  <ESC> [1 1 ; 3 7 v

- Either one or both flag characters can be deleted from the Touch-Sense Report:

  1. The following sequence defines a Touch-Sense Format with only one flag character:

     <ESC> [<f1> v

  2. The following sequence defines a Touch-Sense Format with no flag characters:

     <ESC> [v

Touch-Sense Report Terminator Characters

Terminator characters are defined by sending the 1780A the following sequence:

<ESC> [<t1> ; <t2> w

- The default values of <t1> and <t2> are z and <CR>, respectively.
- <t1> and <t2> can be set to any ASCII character or control code.
- <t1> and <t2> are ASCII numeric strings representing the decimal value of the desired character code. For example, the following sequence selects the terminator characters n and <LF>:

  <ESC> [1 1 0 ; 1 0 w

- Leading zeros (zeros to the left of digits) in <t1> and <t2> are ignored. For example, both of these sequences select the flag characters % and <LF>:

  <ESC> [0 3 7 ; 0 1 0 w
  <ESC> [3 7 ; 1 0 w

- Either one or both terminator characters can be deleted from the Touch-Sense Format:

  1. The following sequence defines a Touch-Sense Format with one terminator character:

     <ESC> [<t1> w

  2. The following sequence defines a Touch-Sense Format with no terminator characters: <ESC> [w

Touch-Sense Key Numbers

The Touch-Sense Key number is usually reported as a 3-digit ASCII numeric string, but the number can be reported in binary format as a single byte.

- Send one of the following sequences to the 1780A to select the ASCII Touch-Sense Report Mode:

  <ESC> [z
  <ESC> [0 z
  <ESC> [1 z

  1. This is the default mode.

  2. In this mode, the Touch-Sense Key number is reported as a 3-digit ASCII numeric string from 001 (upper left corner) through 060 (lower right corner).

The 1780A default-format Touch-Sense Report conforms to the ANSI standard command string format. The two flag characters are <ESC> and [. The Touch-Sense Key number is reported as a 3-digit, zero-filled ASCII numeric string (001 through 060). The two terminator characters are z and <CR>. For example, pressing Touch-Sense Key 33 would result in the sequence <ESC> [0 3 3 z <CR>. The carriage return line terminator <CR> is included for compatibility with the many systems (such as the Fluke 1720A) that require a line-oriented input.

To allow maximum flexibility in making Touch-Sense Reporting compatible with various system requirements, the 1780A accepts input commands that redefine or eliminate each flag and terminator character. In addition, the format of the Touch-Sense Key number can be redefined to be a single 8-bit binary byte in place of the ASCII numeric sequence.

Touch-Sense Report Flag Characters

Flag characters are defined by sending the 1780A the following command string:

<ESC> [<f1> ; <f2> v

- The default values of <f1> and <f2> are <ESC> and [, respectively.
- <f1> and <f2> can be set to any ASCII character or control code.
- <f1> and <f2> are ASCII numeric strings representing the decimal value of the desired character code. For example, <ESC> [4 2 v selects an asterisk (*) as a single flag character.
- Leading zeros (zeros to the left of digits) in <f1> and <f2> are ignored. For example, both of these sequences select the flag characters <VT> and %:

  <ESC> [0 1 1 ; 0 3 7 v
  <ESC> [1 1 ; 3 7 v

- Either one or both flag characters can be deleted from the Touch-Sense Report:

  1. The following sequence defines a Touch-Sense Format with only one flag character:

     <ESC> [<f1> v

  2. The following sequence defines a Touch-Sense Format with no flag characters:

     <ESC> [v

Touch-Sense Report Terminator Characters

Terminator characters are defined by sending the 1780A the following sequence:

<ESC> [<t1> ; <t2> w

- The default values of <t1> and <t2> are z and <CR>, respectively.
- <t1> and <t2> can be set to any ASCII character or control code.
- <t1> and <t2> are ASCII numeric strings representing the decimal value of the desired character code. For example, the following sequence selects the terminator characters n and <LF>:

  <ESC> [1 1 0 ; 1 0 w

- Leading zeros (zeros to the left of digits) in <t1> and <t2> are ignored. For example, both of these sequences select the flag characters % and <LF>:

  <ESC> [0 3 7 ; 0 1 0 w
  <ESC> [3 7 ; 1 0 w

- Either one or both terminator characters can be deleted from the Touch-Sense Format:

  1. The following sequence defines a Touch-Sense Format with one terminator character:

     <ESC> [<t1> w

  2. The following sequence defines a Touch-Sense Format with no terminator characters: <ESC> [w

Touch-Sense Key Numbers

The Touch-Sense Key number is usually reported as a 3-digit ASCII numeric string, but the number can be reported in binary format as a single byte.

- Send one of the following sequences to the 1780A to select the ASCII Touch-Sense Report Mode:

  <ESC> [z
  <ESC> [0 z
  <ESC> [1 z

  1. This is the default mode.

  2. In this mode, the Touch-Sense Key number is reported as a 3-digit ASCII numeric string from 001 (upper left corner) through 060 (lower right corner).

- Send <ESC> [2 z to the 1780A to select the Binary Touch-Sense Report Mode.

  1. Table 4A-6 lists the Touch-Sense Report for each Touch-Sense Key when the DATA BITS FUNCTION switch (on the 1780A rear panel) is set to the 8-BITS position.

  2. Bit 8 can be used to distinguish the source of the codes with the DATA BITS FUNCTION switch set to the 8-BITS position.

     a. Touch-Sense Key codes set bit 8 to 1.

     b. Codes generated by a Y1720 keyboard through an optional 1780A-001 Keyboard Interface leave bit 8 reset to 0.

  3. If the DATA BITS FUNCTION switch is set to the 7-BITS position or if your computer cannot read bit 8 as a data bit, binary Touch-Sense Key codes will be reported or interpreted as code numbers 0 through 59. These codes include all ASCII control code patterns as well as many other valid ASCII characters.

CLEAR THE OUTPUT BUFFER -- <ESC> [9 z

Send <ESC> [9 z to clear the 48-character output buffer.

REQUEST POLLED TOUCH-SENSE REPORT -- <ESC> [3 z

Send <ESC> [3 z to the 1780A to request the last Touch-Sense Report when in the Polling Mode. This report contains the code number of the last Touch-Sense Key accepted by the 1780A.

NOTE

If there is no Touch-Sensitive Overlay input pending during a poll, the 1780A returns a key value of 000 in the ASCII Touch-Sense Report format or a value of FF, hexadecimal, in the binary Touch-Sense Report format.

ANSI STANDARD CONTROL SEQUENCE SUMMARY TABLE

Table 4A-7 summarizes each control sequence and its control action.

Table 4A-6. Touch-Sense Reports -- 8-Bit Data

TOUCH-SENSE KEY NUMBER	TOUCH-SENSE REPORT		
	DECIMAL	HEXADECIMAL	BINARY
1	128	80	1000 0000
2	129	81	1000 0001
3	130	82	1000 0010
4	131	83	1000 0011
5	132	84	1000 0100
6	133	85	1000 0101
7	134	86	1000 0110
8	135	87	1000 0111
9	136	88	1000 1000
10	137	89	1000 1001
11	138	8A	1000 1010
12	139	8B	1000 1011
13	140	8C	1000 1100
14	141	8D	1000 1101
15	142	8E	1000 1110
16	143	8F	1000 1111
17	144	90	1001 0000
18	145	91	1001 0001
19	146	92	1001 0010
20	147	93	1001 0011
21	148	94	1001 0100
22	149	95	1001 0101
23	150	96	1001 0110
24	151	97	1001 0111
25	152	98	1001 1000
26	153	99	1001 1001
27	154	9A	1001 1010
28	155	9B	1001 1011
29	156	9C	1001 1100
30	157	9D	1001 1101

Table 4A-6. Touch-Sense Reports -- 8-Bit Data (cont)

TOUCH-SENSE KEY NUMBER	TOUCH-SENSE REPORT		
	DECIMAL	HEXADECIMAL	BINARY
31	158	9E	1001 1110
32	159	9F	1001 1111
33	160	A0	1010 0000
34	161	A1	1010 0001
35	162	A2	1010 0010
36	163	A3	1010 0011
37	164	A4	1010 0100
38	165	A5	1010 0101
39	166	A6	1010 0110
40	167	A7	1010 0111
41	168	A8	1010 1000
42	169	A9	1010 1001
43	170	AA	1010 1010
44	171	AB	1010 1011
45	172	AC	1010 1100
46	172	AD	1010 1101
47	173	AE	1010 1110
48	174	AF	1010 1111
49	175	B0	1011 0000
50	176	B1	1011 0001
51	177	B2	1011 0010
52	178	B3	1011 0011
53	179	B4	1011 0100
54	180	B5	1011 0101
55	181	B6	1011 0110
56	182	B7	1011 0111
57	183	B8	1011 1000
58	184	B9	1011 1001
59	185	BA	1011 1010
60	186	BB	1011 1011

Table 4A-7. ANSI Standard Control Sequence Summary

NAME	SEQUENCE	DESCRIPTION
CURSOR TYPE	<ESC> [0 x *	Blinking, reverse-video block.
	<ESC> [1 x	Steady, reverse-video block.
	<ESC> [2 x	No cursor displayed.
REQUEST POLLED TOUCH-SENSE REPORT	<ESC> [3 z	Request that the 1780A send the last Touch-Sense Report when in the Polling Mode.
CURSOR CONTROL	<ESC> [n A	Up n lines. Default is 1.
	<ESC> [n B	Down n lines. Default is 1.
	<ESC> [n C	Right n columns. Default is 1.
	<ESC> [n D	Left n columns. Default is 1.
	<ESC> [l ; c H	Move to line l and column c.
	<ESC> D	Down 1 line, scroll up at the screen bottom.
	<ESC> M	Up 1 line, scroll down at the screen top.
	<ESC> E	Move to the start of the next line down, scroll up at screen bottom.
CURSOR POSITION REPORTING	<ESC> [6 n	Requests active position (to the 1780A).
	<ESC> [l ; c R	Active position as line l and column c (from the 1780A).
MODE SELECTION SEQUENCES: <ESC> [n ; n ; n ; .... p		
Character Size	<ESC> [p *	Normal-size, entire display.
	<ESC> [0 p	Normal-size, entire display.
	<ESC> [1 p	Double-size, entire display.
NOTE: Normal and double-sized characters cannot be intermixed.		
Standard Graphics	<ESC> [2 p *	Standard Graphics off.
	<ESC> [3 p	Standard Graphics on.
NOTE Standard Graphics Mode selection does not occupy a display location.		
Auto Line Feed	<ESC> [6 p	Enable Auto Line Feed Mode.
	<ESC> [7 p	Disable Auto Line Feed Mode.
NOTE: The AUTO LINE FEED FUNCTION switch sets the default condition.		
* Default condition.		

Table 4A-7. ANSI Standard Control Sequence Summary (cont)

NAME	SEQUENCE		DESCRIPTION
MODE SELECTION SEQUENCES (cont)			
Auto Wrap-Around	<ESC> [1 0 p		Enable Auto Wrap-Around Mode.
	<ESC> [1 1 p		Disable Auto Wrap-Around Mode.
NOTE: The AUTO WRAP-AROUND FUNCTION switch sets the default condition.			
Auto Beep	<ESC> [1 2 p		Enable auto beep.
	<ESC> [1 3 p	*	Disable auto beep.
NOTE: Auto Beep can only be disabled for Touch-Sense Key inputs.			
Auto Repeat	<ESC> [1 4 p		Enable auto repeat.
	<ESC> [1 5 p	*	Disable auto repeat.
Polling Mode	<ESC> [1 6 p		Enable the Polling Mode.
	<ESC> [1 7 p	*	Disable the Polling Mode.
CHARACTER ENHANCEMENT SEQUENCES: <ESC> [n ; n ; n ; ... m			
	<ESC> [m	*	All enhancements off.
	<ESC> [0 m		All enhancements off.
	<ESC> [1 m		Increased intensity.
	<ESC> [4 m		Underline.
	<ESC> [5 m		Blinking.
	<ESC> [7 m		Reverse video.
	<ESC> [8 m		Alternate character set.
	OR		
	<SO> (<CTRL/N>)		Alternate character set.
	<SI> (<CTRL/O>)		Standard character set.
NOTE: Each single or multiple sequence occupies one display position.			
ERASE IN DISPLAY	<ESC> [0 J	*	Active position to end of screen.
	<ESC> [1 J		From start of screen through active position.
	<ESC> [2 J		Entire screen.
* Default condition.			

Table 4A-7. ANSI Standard Control Sequence Summary (cont)

NAME	SEQUENCE	DESCRIPTION
ERASE IN LINE	<ESC> [0 K *	Active position to end of line.
	<ESC> [1 K	Start of line through active position.
	<ESC> [2 K	Entire line.
TOUCH-SENSE REPORTING		
Touch-Sense Format Commands (to 1780A)	<ESC> [1 z	Enable ASCII report format. Default condition.
	<ESC> [2 z	Enable binary report format.
	<ESC> [<f1> ; <f2> v	Define flags characters.
	<ESC> [<t1> ; <t2> w	Define terminator characters:
Touch-Sense Report (from 1780A)	[f1] [f2] nnn [t1] [t2]	ASCII format. Default condition.
	[f1] [f2] b [t1] [t2]	Binary format.
CLEAR OUTPUT BUFFER	<ESC> [9 z	Clear the output buffer of Touch-Sense Reports only.
* Default condition.		

INTRODUCTION

The information in this section gives you two programs for an example 1780A display (Figure 4B-1). For this example, the Fluke 1720A Instrument Controller is used as the host computer.

EXAMPLE PROGRAM LISTING NUMBER 1

The program in the following listing was written on a Fluke 1720A Instrument Controller in Fluke-Enhanced BASIC, which is very similar to most BASIC languages. The important points of this program are as follows:

- Statements 90 through 170 set up the ANSI control sequences.

  1. The ANSI control sequences are used to select 1780A modes of operation such as inverse video, graphics, or double-size characters. The 1780A modes of operation are described in Section 4A.

  2. Note that statement 150 configures the 1780A Touch-Sense Report Format in a manner that is compatible with the 1720A. This format eliminates both default report flag characters and replaces both of the default report terminator characters with a single terminator: LF (line-feed).

- Statements 250 through 500 create the display by:

  1. Selecting double-size characters and Standard Graphics Mode.

  2. Drawing the selection boxes using the appropriate graphics.

  3. Printing numbers inside the boxes using reverse video.

- Statements 570 through 710 form the RS-232-C interrupt service routine.

  1. This routine is entered whenever the 1720A receives an EOL (end-of-line) character. In this case, the EOL character is an LF (line-feed).

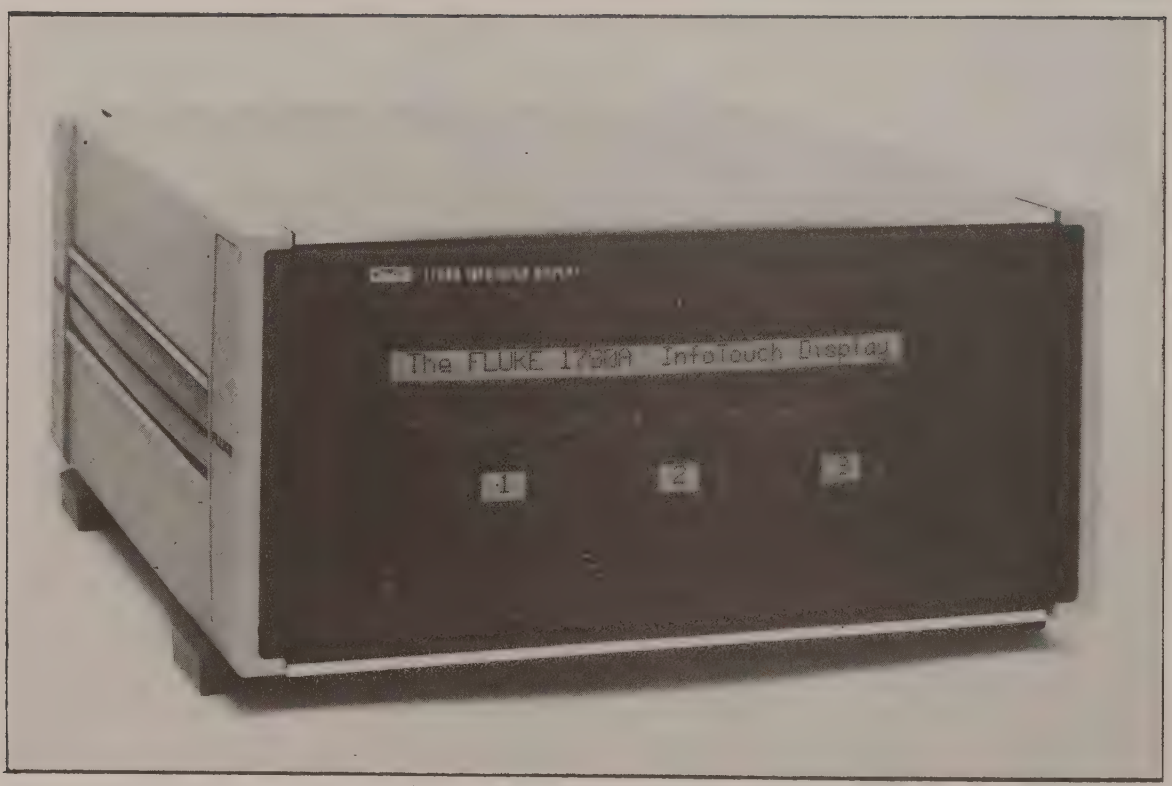


Figure 4B-1. Example 1780A Display

2. The service routine is enabled through statements 250, 260, and 270. These statements open the RS-232 port to the 1780A and then direct the program to go to statement 580 on receipt of a port interrupt.

- Statement 580 reads the Touch Sense Report string into the string variable K$. Since the flags were eliminated in statement 150 and the 1720A operating system deletes the line-feed terminator, the only thing left in K$ is three ASCII digits representing the Touch-Sense key pressed. Statement 590 converts this string to a numeric value and assigns that numeric value to K. The statements following 590 test K to see if it is a "live" key. If it is "live," it acts on the response. Otherwise, it is simply ignored.

```
10! Fluke 1780A DEMONSTRATION PROGRAM  'DEMO.BAS' 5/20/82
20!       WRITTEN FOR THE FLUKE 1720A INSTRUMENT CONTROLLER IN FLUKE BASIC
30!
40!       1780A configured as follows: parity off, 8 data bits, 1 stop bit
50!
60!*****************************************************************************
70! Define screen enhancement strings:
80!
90  EL$=CHR$(27)+'['          ! <ESC> [ ANSI control sequence identifier
100 DS$=EL$+'1p'              ! Double size
110 IV$=EL$+'7m'              ! Inverse video
120 NV$=EL$+'m'               ! Normal video
130 GO$=EL$+'3p'              ! Graphics mode ON
140 GF$=EL$+'2p'              ! Graphics mode OFF
150 CT$=EL$+'v'+EL$+'10w'     ! Confine Touch Sense Report format
160!                              for no flag and <line feed> terminator
170 NC$=EL$+'2x'              ! No cursor
180!
190!*****************************************************************************
200 CLOSE 1,2
210!NOW START THE PROGRAM
220!
230!*****************************************************************************
240!
250 OPEN 'kb1:' AS NEW FILE 1      ! open output to 1780A
260 OPEN 'kb1:' AS OLD FILE 2      ! open input from 1780A
270 ON #2 GOTO 580                 ! Interrupt trap for incoming data
280!
290 PRINT #1,CT$+NC$+DS$      ! Configure Touch Sense/no cursor/double size
300!
310 PRINT #1                       ! Space down one
320 PRINT #1,' '+IV$;              ! Inverse video
330 PRINT #1, ' The FLUKE 1780A InfoTouch Display ';
340 PRINT #1,NV$;                  ! Normal video
350 PRINT #1                       ! Space down one
360 PRINT #1                       ! Space down one
370 PRINT #1, '    A light touch is all it takes'
380!
```

```
390 PRINT #1,GO$;                    ! Graphics on
400 PRINT #1,'     1444440   1444440   1444440   ! Make box outlines
410 PRINT #1,'     9     9   9     9   9     9'
420 PRINT #1,'     9     9   9     9   9     9'
430 PRINT #1,'     3444442   3444442   3444442';
440 PRINT #1,GF$;
450
460 PRINT #1,EL$+'7;5H'+IV$+' 1 '+NV$;          ! Print numbers
470 PRINT #1,EL$+'7;17H'+IV$+' 2 '+NV$;         ! in reverse video
480 PRINT #1,EL$+'7;29H'+IV$+' 3 '+NV$;         !
490!
500 GOTO 500                                    ! Done loop here
510
520!*************************************************************************
530!
540!Process the touch sense inputs
550!
560!*************************************************************************
570!
580 INPUT #2,K$                          ! Get the touch sense input
590 K=VAL(K$)                            ! Convert to a number
600!
610!Check the inputs for valid key numbers: (#51, #55, #59)
620!
630 IF K=51 THEN T-1 ELSE IF K=55 THEN T=2 ELSE IF K=59 THEN T=3 ELSE 700
640 PRINT #1,CHR$(7);-                   ! Send a beep to acknowledge
650!if T=1 the gosub 1000 <= Possible test routine as a result of #1 input
660!if T=2 the gosub 2000 <= Possible test routine as a result of #2 input
670!if T=3 the gosub 3000 <= Possible test routine as a result of #3 input
680!
690 PRINT #1,CHR$(7);                    ! Send a beep to acknowledge
700 PRINT '1780A input is',K             ! Display input on host
710 RESUME                               ! Exit interrupt trap
```

EXAMPLE PROGRAM LISTING NUMBER 2

Example program number 2 gives the same results as program number 1 except that program number 2 demonstrates the use of the DATA statements in configuring the 1780A InfoTouch Display. This statement has each Touch Sense Key "point" to a specified test number. The data statements are arranged in two number sequences. The first number is the actual display square, and the second number is the test that is desired. The advantage of this approach is the large display areas (more than one square) can easily be set up to activate a desired test. Also, this approach effectively shuts off Touch-Sense keys that are not desired by simply omitting them or setting them to zero. The important point of program number 2 is that statements 540 through 580 set up the configuration array T$. This is set up by reading the first number in the data statement pair as a subscript and the second number as the value of the array. Then, in the service routine, simply assign the array value (at the number that is input as a subscript) to test T.

```
10! Fluke 1780A DEMONSTRATION PROGRAM  'DEMO.BAS' 5/20/82
20!       -Show effectiveness of DATA statements for Touch Sense control-
30!
40!       WRITTEN FOR THE FLUKE 1720A INSTRUMENT CONTROLLER IN FLUKE BASIC
50!
60!       1780A configured as follows: parity off, 8 data bits, 1 stop bit
70!
80!*****************************************************************************
90 Define screen enhancement strings:
100
110 EL$=CHR$(27)+'['          ! <ESC> [ ANSI control sequence identifier
120 DS$=EL$+'1p'              ! Double size
130 IV$=EL$+'7m'              ! Inverse video
140 NV$=EL$+'m'               ! Normal video
150 GO$=EL$+'3p'              ! Graphics mode ON
160 GF$=EL$+'2p'              ! Graphics mode OFF
170 CT$=EL$+'v'+EL$+'10w'     ! Confine Touch Sense Report format
180!                              for no flag and <line feed> terminator
190 NC$=EL$+'2x'              ! No cursor
200
210!*****************************************************************************
220!
230! Data Statements for the Touch Sense configuration array
240!
250! Format of data statements is: DATA <TSO #>, <effective output #>
260!  i.e. for the first data statement, pressing square #41 will
270!  translate to a 1 in the array 'TS', i.e. TS(41)=1 etc.
280!  Any TSO input not identified will thus translate to a 0, i.e. TS(5)=0
290!
300! This gives us the flexibility to easily define the effect of pressing a
310! Touch Sense Square, or to (in software) turn off any or all Touch Sense
320! Squares. In the case of this demo, we can easily configure the TSO
330! Squares around the number on the screen to allow for a larger effective
340! target area.
350!
360  DATA 41,1
370  DATA 42,1
380  DATA 51,1
390  DATA 52,1
400  DATA 44,2
410  DATA 45,2
420  DATA 46,2
430  DATA 54,2
440  DATA 55,2
450  DATA 56,2
460  DATA 48,3
470  DATA 49,3
480  DATA 50,3
490  DATA 58,3
500  DATA 59,3
510  DATA 60,3
520  DATA 1000,1000              ! END OF LOOP # = 1000
530!
540! DIM TS (60)                 ! Set up Touch-Sensitive Overlay array
```

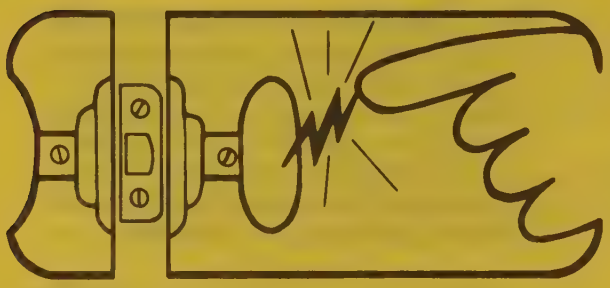
```
550  READ A                          ! Get data item
560  IF A=1000 THEN 590              ! Check for End of Loop Data
570  READ TS (A)                     ! Put data in Touch-Sensitive Overlay array
580  GOTO 550
590!
600!*************************************************************************
610!
620! NOW START THE PROGRAM
630!
640!*************************************************************************
650! CLOSE 1,2
660 OPEN 'kb1:' AS NEW FILE 1        ! open output to 1780A
670 OPEN 'kb1:' AS OLD FILE 2        ! open input from 1780A
680 ON #2 GOTO 980                   ! Interrupt trap for incoming data
690!
700 PRINT #1,CT$+NC$+DS$     ! Configure Touch Sense/no cursor/double size
710!
720 PRINT #1,EL$+'2;38H'+NV$+EL$+'2;1H;     ! Pre-Place Attributes
730                                         ! off character to turn
740                                         ! off inverse video
750
760 PRINT #1,' '+IV$;                ! Inverse video
770 PRINT #1, ' The FLUKE 1780A InfoTouch Display ';
780 PRINT #1                         ! Space down one
790 PRINT #1                         ! Space down one
800 PRINT #1, '    A light touch is all it takes'
810!
820 PRINT #1,GO$;                    ! Graphics on
830 PRINT #1,'     1444440   1444440   1444440   ! Make box outlines
840 PRINT #1,'     9     9   9     9   9     9'
850 PRINT #1,'     9     9   9     9   9     9'
860 PRINT #1,'     3444442   3444442   3444442';
870 PRINT #1,GF$;
880
890!Pre-Place the Attributes off character to turn off inverse video
900!
910 PRINT #1,EL$+'7;9H'+NV$+EL$+'7;21H'+NV$+EL$+7;33H'+NV$;
920!
930 PRINT #1,EL$+'7;5H'+IV$+' 1 '                ! Insert numbers
940 PRINT #1,EL$+'7;17H'+IV$+' 2 '               ! in reverse video
950 PRINT #1,EL$+'7;29H'+IV$+' 3 '               !
960!
970 GOTO 970                                     ! Done loop here
980
990!*************************************************************************
1000!
1010!Process the touch sense inputs
1020!
1030!*************************************************************************
1040!
1050 INPUT #2,K$                                 ! Get the touch sense input
1060 K=VAL(K$)                                   ! Convert to a number
1070!
```

```
1080!Check the inputs for valid key numbers: (#41-42, #44-46, #48-52,
     #54-56, #58-60)
1090!
1100 T=TS(K)
1110! if T=1 the gosub 1000 <= Possible test routine as a result of #1 input
1120! if T=2 the gosub 2000 <= Possible test routine as a result of #2 input
1130! if T=3 the gosub 3000 <= Possible test routine as a result of #3 input
1140!
1150 IF T<>0 THEN PRINT #1,CHR$(7);          ! Send a beep to acknowledge
1160 PRINT '1780A input is',K,'test #';T     ! Display input on host
1170 RESUME                                  ! Exit interrupt trap
```

static awareness

A Message From

John Fluke Mfg. Co., Inc.



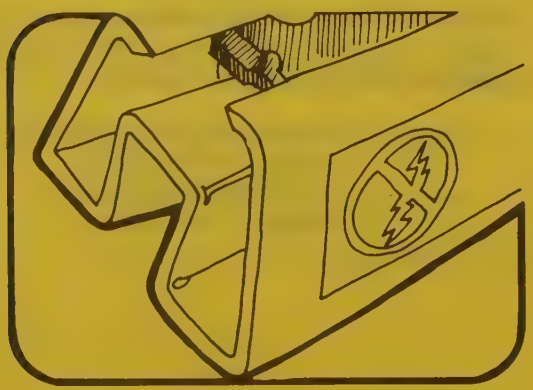
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

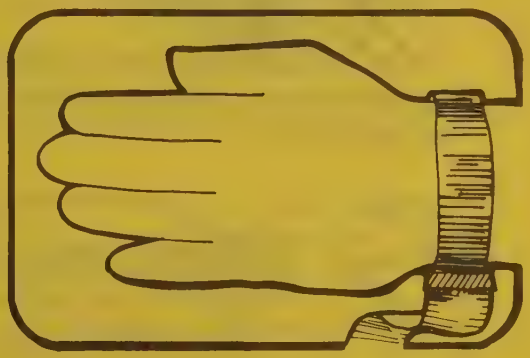
The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⊗"

The following practices should be followed to minimize damage to S.S. devices.

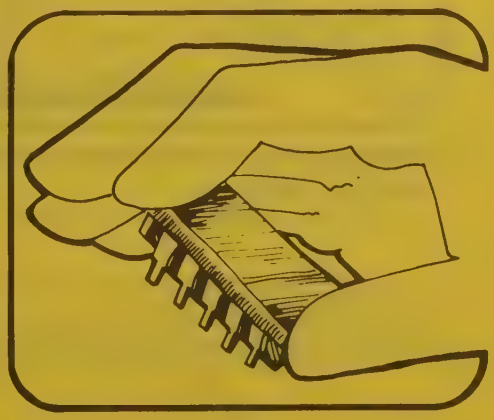
1. MINIMIZE HANDLING



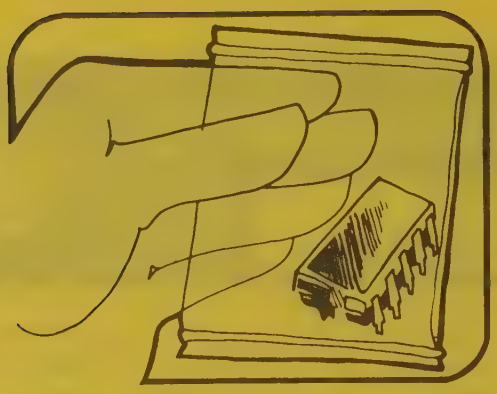
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



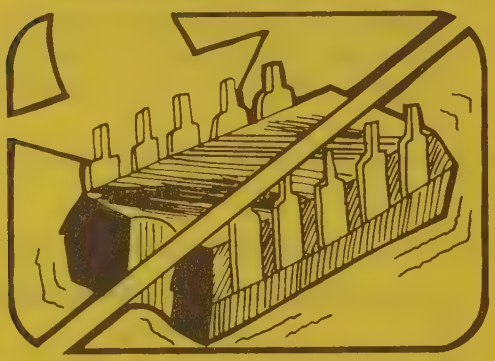
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



4. HANDLE S.S. DEVICES BY THE BODY



5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT



6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE

7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA

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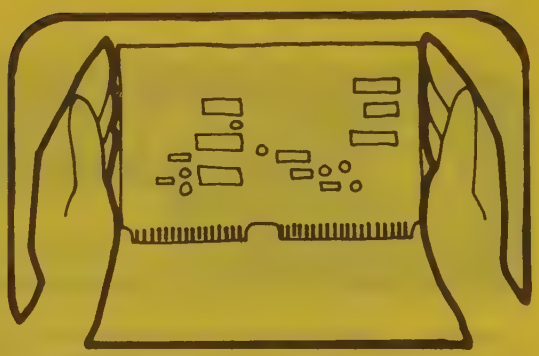
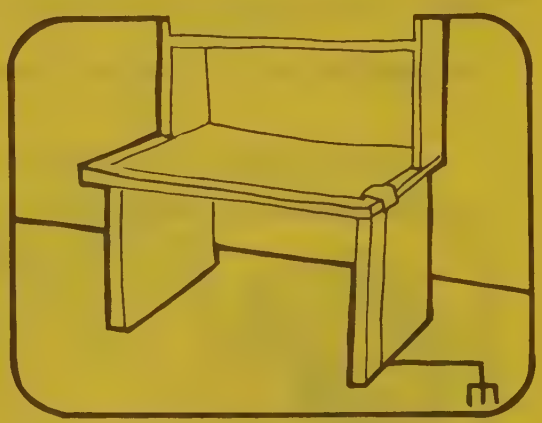


8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS TO PROTECT INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION
10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.
11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

A complete line of static shielding bags and accessories is available from Fluke Parts Department, Telephone 800-526-4731 or write to:

JOHN FLUKE MFG. CO., INC.
PARTS DEPT. M/S 86
9028 EVERGREEN WAY
EVERETT, WA 98204

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Section 5
Theory of Operation

INTRODUCTION

The information is this section describes the theory of operation of the 1780A InfoTouch Display. Figure 5-1 is an overall block diagram of the 1780A. Mnemonics are defined in Section 9. The - symbol is used with mnemonics to indicate the inverted state of the mnemonic.

The 1780A InfoTouch Display receives ASCII characters from a host system over the RS-232-C interface. These ASCII characters cause the 1780A to respond on one of the following output devices:

- Video display
- Audible beeper
- RS-232-C output
- LED outputs on the Keyboard Interface, Option 1780A-001.

The user sends ASCII characters to the host system over the RS-232-C interface by closing the contacts of the keys on the transparent overlay with 6 lines of 10 touch sensitive switches and keyboards connected to the Keyboard Interface.

MICROPROCESSOR AND ROM

The microprocessor (U28) runs a programs which is contained in the ROM (Read-Only Memory), U27). The program occupies the microprocessor address space from 0-1FFF (hexadecimal). The program causes the microprocessor to perform the following operations:

1. Set levels on the CRU (Communication Register Unit) Bit I/O output lines.
2. Read levels on the CRU Bit I/O input lines.
3. Scan the keyboards and configuration switches.
4. Send and receive characters on the RS-232-C interface.
5. Maintain the character image in the RAM (Random-Access Memory, U20).
6. Control the CRT Controller (U33).

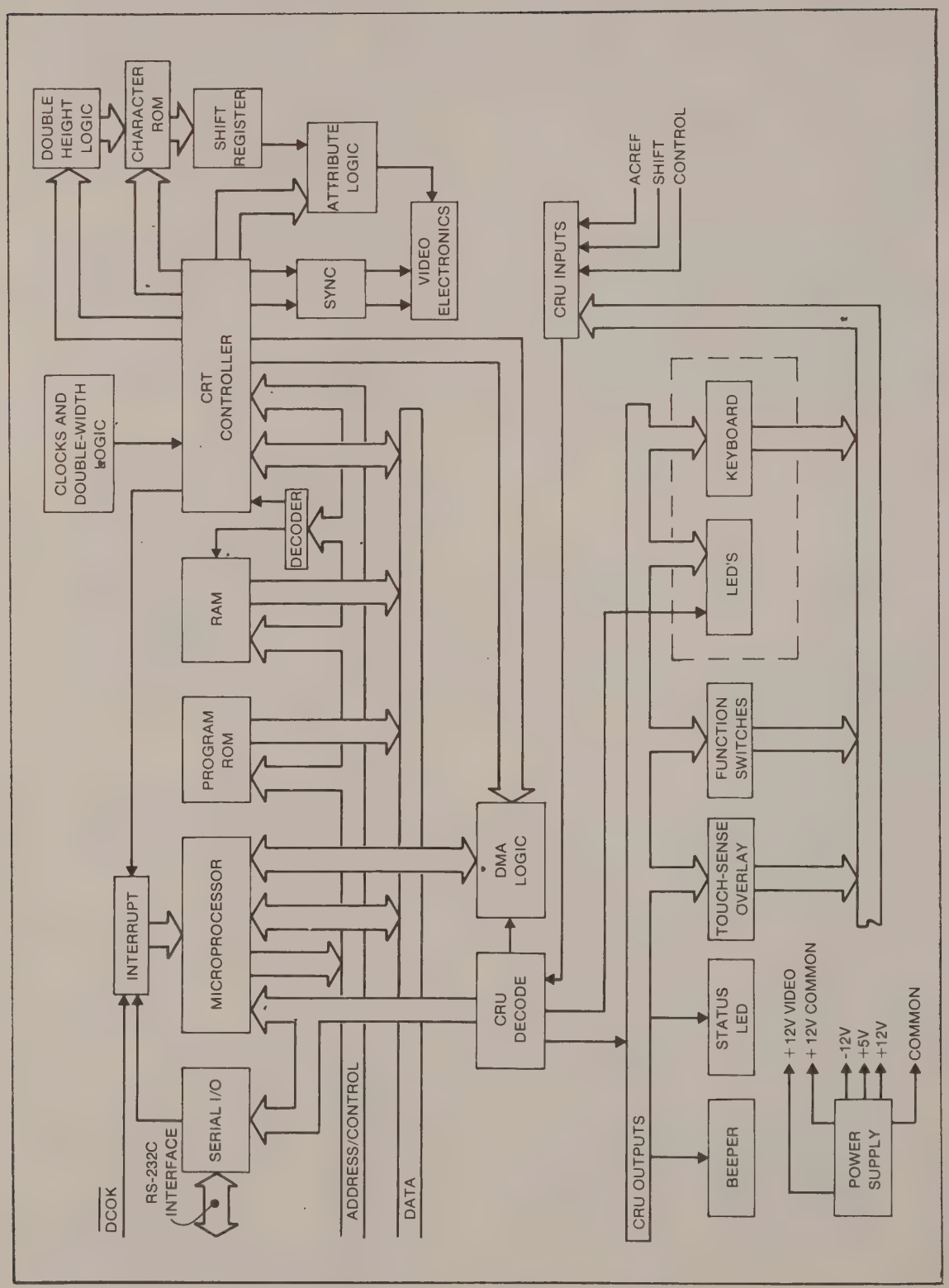

Figure 5-1. Overall Block Diagram

When power is first applied to the 1780A, the DCOK (dc power supply voltages all right) line begins slowly rising to +5V. Until DCOK reaches a high logic level, it causes a reset interrupt to be applied to the microprocessor through U38. When DCOK reaches a high logic level, the reset condition is removed and the program is restarted.

CRU INPUTS AND OUTPUTS

CRU operations are single bit transfers. During CRU operations the bit address appears on address lines A01-A11 while A12 and A13 are low. To write, the microprocessor places the output data bit on A00 and strobes the CRUCLK (Communications Register Unit Clock) line. To read, the microprocessor inputs one bit of data from the CRUIN (Communications Register Unit Input) line.

KEYBOARD AND CONFIGURATION SWITCH SCANNING

To scan a keyboard the microprocessor enables one column of keys by placing a 6 bit value of G0-G5 (U11). This value enables one of the outputs of the column decoder (U10) in the 1780A and the decoder in the keyboard connected via the 1780A-001 Keyboard Interface. These decoders are active-low open collector devices. When no keys are pushed, the keyboard row inputs are pulled high by Z3. If a key is pushed in the enabled column, the corresponding row and column lines are connected and the active column line pulls the row line to a logic 0. The state of the keyboard row lines is read by the microprocessor through U39. Each column is scanned in turn to find all active keys. Note that the Touch-Sense Overlay and the Keyboard Interface share the same input lines. To prevent a conflict, when the microprocessor is scanning the optional keyboard, G2-G3 are set high to disable the operator keyboard column selector. To scan the operator keyboard, G5-G6 are set high to disable the optional keyboard.

The FUNCTION switches may be viewed as a keyboard with one switch per column. To scan the switches the microprocessor places a 4-bit code on G0-G3 which enables one of the outputs on U42. If the selected switch is closed, this causes the FUNCTION switch input on U36 to be pulled low. If the selected switch is open, the input on U36 is pulled high by R32. The microprocessor may read the state of this input to determine the position of the configuration switches. Note that SW1 and SW2 are always active and have dedicated inputs to U36. The microprocessor may read the position of these switches at any time.

The state of the CRTL and SHIFT keys on the optional keyboard are read at dedicated inputs on U36.

Table 5-1. CRU Addresses

NAME	BUS ADDRESS	IN/OUT	FUNCTION
KBSTB-	000	Out	Strobe option keyboard LED latch
	000	In	Configuration switch input
CTRL-	002	In	Option 1780A-001 CTRL key line
SHIFT-	004	In	Option 1780A-001 SHIFT key line
ACREF	006	In	Line frequency for 50/60 Hz selection
SW1	008	In	Odd/Even parity switch
SW2	00A	In	On/Off parity switch
T-IN	00C	In	Test input -- Undefined
T-MODE	00E	In	Test mode - Undefined
	010	Out	ACTIVITY LED
SRTS-	020	Out	Secondary Request to Send
	030	Out	Beeper enable
G0-G5	040-04A	Out	General purpose control lines
S60HZ	04C	Out	Enables 60 Hz operation
DBLSZ	04E	Out	Enable double size operation
	040-04E	In	Key row input
	C00-C3E	In/Out	UART control/status

OPTIONAL KEYBOARD OUTPUTS

The optional keyboard output plus has five logic lines which are set by the processor in response to a set of escape sequences (see Section 4A). (In addition, the Y1720 Keyboard Accessory has a clicker and two dedicated LEDs to indicate optional modes of the software, normally PAGE MODE and CAPS LOCK.) To set one of these output lines the microprocessor places a 3-bit codes on G1, G5, and G6 and the desired data value on G0. These are connected to the select and data input (respectively) of the addressable latch on the optional 1780A-001 Keyboard Interface. The microprocessor then accesses CRU address 000 which strobes the data into the latch. In the case of the clicker, the microprocessor sets the appropriate output low then high to clock the one-shot, which determines the duration of the clicker drive. The LED lines are buffered by the addressable latch on the Keyboard Interface to sink up to 24 mA.

ACTIVITY LED, TEST MODE AND TEST INPUT

The ACTIVITY LED is controlled by the microprocessor to indicate that some portion of the software is working correctly. During normal operation of the 1780A this LED should be blinking. To enable the ACTIVITY LED, the microprocessor writes a low level to CRU address 010 which resets the output of U23. When enabled the LED may be disabled by writing a high level to the same address.

The microprocessor reads the logic levels at the TEST MODE and TEST INPUT test points through U36. These test points are intended for future expansion of the 1780A self test routines.

RS-232-C INTERFACE

The microprocessor communicates with the UART (U35) through CRU operations. When the UART has received a character on the RS-232 line or has finished transmitting a character, it interrupts the microprocessor by bringing the UNIT- (Microprocessor Interrupt Not) line low. If no other interrupts are pending, the program will service the UART interrupt and reset the UNIT- to the inactive (high) state.

The UART is connected to the standard 25-pin D-type connector through the RS-232-C level translator/buffer (U43 and U44).

The microprocessor may set the state of the SRTS- line by writing to CRU address 020 which sets the output of U5. The output of U5 is translated by U44 and is a part of the RS-232-C Interface.

CHARACTER MEMORY

The system RAM, U20, resides in the memory map of the microprocessor from 2000-2FFF. (This address is decoded by U22.) The RAM contains the workspace registers, character buffers for I/O, other system variables, and an image of the character display screen. The 2K RAM is logically divided into 16 lines of 128 bytes each. The first 80 bytes of each line are reserved for the display image.

To display a character on the screen the microprocessor stores its ASCII code in the display memory at the appropriate location. The DMA (Direct-Memory Access) hardware transfers the characters to the CRT Controller as they are needed to refresh the display.

THE CRT CONTROLLER

The CRT Controller (U33) is responsible for providing character codes to the character generator hardware synchronized with the monitor electronics. The CRT Controller has four registers for access by the microprocessor. Table 5-2 lists the addresses decoded by U22. U16 is used to inhibit chip select during the lower byte of a word transfer. Read and write operations have separate addresses to prevent read-before-write operations from affecting the internal status of the device.

Table 5-2. Decoded Addresses

NAME	BUS ADDRESS	IN/OUT	FUNCTION
Status	3002	In	Status to microprocessor
Control	3006	Out	Control commands from microprocessor
Param	3004	Out	Command parameters from microprocessor

When initialized, the CRTC (CRT Controller) obtains characters through the Direct Memory Access (DMA) circuit and forwards them to the character generator along with the selected attributes and the current line count. The CRTC controls the synchronization of the monitor electronics with the HRTC (Horizontal Retrace) and VRTC (Vertical Retrace) signals.

CHARACTER GENERATION

Every character is stored in memory as one byte of ASCII data, but each character is represented on the screen as 14 bytes of dots which form the shape of the character. Translating between these forms is called character generation.

The CRT Controller presents a 7-bit ASCII code to the address inputs of the character generating ROM (U32). Four more bits of address come from the line counter (U6) which is synchronized to the line count of the CRT Controller by U31, U16, and U18. The line counter indicates which of the 14 lines of the character cell is currently being displayed. The output of the ROM is an 8-bit pattern for the current line of the selected character. This data is latched into the shift register (U8) at the beginning of the next character cycle. The load enable line of U8 becomes active when U18 detects the last dot of the current character and the shift register is loaded at the next rising edge of the dot clock. As the shift register is sending 8 dots to the screen, the CRT Controller sends the next code to the character generating ROM.

When the first scan row of the line of characters has been sent to the screen the horizontal retrace signal causes the electron beam of the monitor to advance to the next line. The line counter is incremented and the same 80 character codes are sent through the character generator to display the next scan line. When all 14 scan lines for the current character row are displayed, the process is repeated for the next line of 80 characters.

CHARACTER DMA

The CRT Character has two internal character buffers which hold one line of 80 characters each. While one buffer is being used to display the current line, the second buffer is loaded with the next line. This means that while each line is required by the display 14 times, it is only read from the memory once. Reading the characters from the memory to the CRT Controller is the task of the DMA logic.

When the CRT Controller is ready for a character, DRQ (DMA Request) is asserted. This signal is synchronized to Ø3- (phase 3 inverted) by U17 and sent to the HOLD- (Hold) input of the microprocessor. R4 allows this signal to be inhibited for troubleshooting. HOLDA (Hold Acknowledge) is asserted when the microprocessor tri-states its address and data lines. Through U15, this enables the DMA address buffers (U12 and U13) and enables access to the RAM through U24. HOLDA also acknowledges the transfer to the CRT Controller at DACK- and, through U24, enables one write pulse from U3. The RAM data at the DMA address is transferred to the CRT Controller at the falling edge of WR-. HOLDA also increments the DMA character address counter (U14) in preparation for the next transfer. At the end of 80 transfers, the output of U14 resets itself to zero through U21. This causes the C2 output to fall which, through U15, increments the two DMA line counters (U9 and U7).

When all 16 lines have been transferred to the screen the RC output of U7 is asserted low. This inhibits further DMA transfers until the end of the frame when the VRTC signal, inverted through U38, resets the counter.

At the end of the frame, the CRT Controller interrupts the processor through the interrupt encoding logic (U45). In response to this interrupt, the microprocessor places the scroll offset on G0-G3 and loads it into the DMA line counter (U9) by executing the LREX external control instruction which is decoded by U15 and U22. This strobe also resets the DMA character counter (U14) to guarantee the correct value.

CHARACTER ENHANCEMENT GENERATION

There are five programmable character enhancements associated with every character. These enhancements, in the order that they affect the video signal in hardware, are as follows:

1. Character Set (Optional)
2. Underline
3. Bolding
4. Reverse Video
5. Highlight

Each of these enhancements is programmed by the user through a unique escape sequence (see Subsection 4A). The effect of these sequences is to place a special control character in the display memory which is recognized by the CRT Controller. This character sets the enhancements which are active for every character until the next control character is encountered.

The current attributes are output by the CRT Controller along with the character code. These attributes are implemented as follows:

1. The alternate character set is selected when the CRT Controller GPA1 output goes high. The GPA1 line becomes the high order address input to the character generator ROM (U32) (provided a larger ROM is installed and the address jumper is configured properly).

2. The underline is provided when the CRT Controller GPA2 output goes high. When GPA2 is high and the last scan line of the character is being displayed (recognized by U31 and U24), the underline condition is latched by U34 when the shift register is loaded with the current character. U45 ORs the underline level with the video output of the shift register.

3. Blinking is provided by the CRT Controller through the video suppress line. When active, the video suppress line is delayed by the attribute latch (U34) before inhibiting the video signal (through U45). The video suppress signal is also used by the CRT Controller to blank the screen during horizontal and vertical retrace and while displaying an attribute character.

4. Reverse video, which is also used at the active cursor position, is latched by U34. U46 inverts the video level.

5. Normal video intensity is provided by inhibiting the video signal during one-half of the dot time by gating it through U31, U46, and U40.

   Video highlight is provided by the HLGT (Highlight) signal. HLGT is delayed by U34 and inverted by U15, then is used to force the video signal to be active during the entire dot period.

DOUBLE-SIZE CHARACTERS

The horizontal size of the characters is determined by the rate that bits are sent to the screen (dot rate). Dot rate is determined by the dot clock (Y1), a 12.77 MHz crystal oscillator. Dot clock is used to clock the character shift register. Dot clock is divided by 8 at U4 to advance the character counters in the CRT Controller. When the double-size character mode is enabled, U2 and U21 divide dot clock by two which causes each character to be twice as wide.

The vertical size of the characters is determined by the number of scan lines in each cell. The double-size character mode causes the scan line counter (U6) to only count every other scan line. A 14 line character cell is displayed on 28 scan lines because every count is used twice.

The microprocessor enables the double-size character mode by setting the bit at CRU address 04E to a logic one (U11). In addition, the software resets the CRT Controller for 40 characters per line and causes each character to be stored twice in the display memory (once each for the upper and lower halves). The DBLSZ line also causes the DMA line counter (U7) to inhibit DMA after transferring 16 lines of 40 characters each.

VIDEO SYNCHRONIZATION

The video electronics must refresh the screen at a rate close to the frequency of the power line to maintain a stable display. The microprocessor monitors the ACREF (line power frequency) input to U36 to determine this frequency. ACREF is derived from the AC side of the power supply and converted by U38 to a logic level which follows the sine wave of the power frequency at power up and sets the level on the S60Hz (Select 60 Hz) line (U11) high for 60 Hz and low for 50 Hz.

The horizontal and vertical sync frequencies must be changed to alter the refresh rate of the CRT while remaining within the specifications of the video electronics.

The period between horizontal sync pulses is changed by inhibiting clock pulses to the CRT Controller at U24. The clock inhibit line is active at the beginning of HRTC for a period determined by the value loaded into the counter U25 by U17 and U38. This counter, along with U16, U31, and U23, determines the position and duration of the HORIZ signal within the active period of HRTC.

The period between vertical sync pulses is accomplished by reprogramming the CRT Controller for a different number of character lines per screen and by blanking any lines after the sixteenth by inhibiting the DMA requests at U17.

BEEPER

The tone of the beeper is determined by the LC1 output of the CRT Controller (U33) which is normally a square wave near 3 kHz. The microprocessor sets the bit a CRU address 030 (U5). This signal is ANDed at U21 with the LC1 output, and the resulting signal drives the speaker through U40.

INTRODUCTION

This section of the manual contains maintenance information for the 1780A. This includes service, general maintenance, performance test, access, calibration, and troubleshooting information.

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING UNLESS YOU ARE QUALIFIED TO DO SO.

The performance test is recommended as an acceptance test when the unit is first received, and later as part of a preventative maintenance program to verify proper operation. A 90-day preventative maintenance cycle is recommended to maintain the specifications listed in Section 1 of this manual.

The Calibration Procedures contain directions on adjusting the CRT Electronics Assembly and the power supply.

The Troubleshooting procedure contains step-by-step instructions for diagnosing faults to the module level.

Assembly and disassembly instructions are included for help in replacing major components.

NOTE

The locations of test points, adjustments, and components are shown in Section 9 of this manual.

REQUIRED EQUIPMENT

The equipment required for the Performance Tests, the Calibration Procedures, Troubleshooting, and Access Procedures are listed in Table 6-1. If the recommended equipment is not available, instruments having equivalent specifications may be used. The table lists the tools required for each maintenance task, beginning with the simplest. Each subsequent task may require tools from the previous task(s).

Table 6-1. Required Equipment

EQUIPMENT NOMENCLATURE	MINIMUM USE SPECIFICATIONS	RECOMMENDED EQUIPMENT
DVM		Fluke 8020B
24-pin IC Puller		Fluke Part Number 572339 *
RS-232-C Loopback Connector	Jumper pins 2-3, 4-5	Canon DB-25S
Alignment Tool		Fluke Part Number 572321 *
Torque Screwdriver	7 to 9 in-pound range	Jergens H10SCL-6500
Dual Trace Oscilloscope		Tektronix 465B
Logic Probe		Fluke TC200-01
Jumpers	Two, 10-inch alligator	
Screwdriver	9-inch standard with a 1/4 inch blade and a plastic handle at least 3 inches long	
Resistor	1 Kilohm, 1/2 watt, carbon composition	
Safety Gloves	Soft leather with cuffs long enough to protect wrists from flying glass.	
Full face shield (preferred) or safety goggles		
Lab smock with a zipper	Plastic zipper. No metal parts that could come in contact with the CRT.	
Anti-static Workpad	Approx. 8 by 11 inches.	
Plastic screwdriver	3 inches long minimum with 1/4-inch tip.	Sprage-Goodman GTT-5 or Fluke Part Number 153049 *

* Part of the 1780A Maintenance Kit (part number listed in Section 7).

GENERAL MAINTENANCE

Introduction

The following paragraphs describe general maintenance procedures such as fuse replacement.

Fuse Replacement Procedure

The procedure for replacing the line power fuse is described in Section 2 of this manual.

Voltage Selection Procedure

The procedure for selecting one of the line voltages (100, 120, 220, and 240V ac)is described in Section 2 of this manual.

Preventative Maintenance Program

The Preventative Maintenance Program for the 1780A consists of the following procedures:

1. Run the Performance Test every 90 days to ensure that the InfoTouch Display is operating properly.

2. Clean the air filter on the rear of the InfoTouch Display every 90 days or earlier if site conditions dictate. The procedure for cleaning the air filter is:

   a. Set the POWER switch to 0 (off).

   b. Pull the air filter out of the rear panel.

   c. Wash the air filter in warm, soapy water. Rinse with clean water.

   d. Blot the air filter dry.

   e. Replace the air filter into the opening in the rear panel, carefully working the edges into place.

CAUTION

To prevent damage to the 1780A from foreign matter intake, do not operate the 1780A without the air filter in place.

3. Clean the Touch-Sensitive Overlay every 90 days or as site conditions dictate. Use a moist, soft (non-abrasive) cloth and a mild soap solution to clean the overlay. Do not let the soap solution or water drip down into the bezel.

GENERAL INFORMATION

Before using the Performance Test, Troubleshooting, Calibration Procedures, or Access Procedures, read the following notes. Some of them protect the equipment from damage, and others assure that you understand the terminology used in the procedures.

1. Turn the power off before removing or replacing any connector.

2. The term "normal configuration" means that the 1780A is set up to run normally. In particular:

   a. The pcb is in place and connected.

   b. Regular PROMs are installed.

   c. All covers, wires, and cables are in place.

   d. No test jumpers are installed.

3. Unless otherwise noted, all measurements are made using TP1 on the Main PCB as a ground reference.

4. Anytime you replace a component, you must run the Performance Test to have assurance that the 1780A is fully operational.

5. If this procedure fails to locate the fault, please go over all the steps you made that led up to that point in the procedure before calling your local Fluke Service Center.

ACCESS PROCEDURES

Introduction

The following procedures allow the user to remove and replace any of the modules or assemblies mentioned in the diagnostic procedures found at the end of this section.

Interior Access Procedure

Use the following procedure to access the interior of the 1780A:

1. Set the POWER switch to 0 (off) and disconnect line power.

2. Turn the 1780A on its side.

3. Remove the screws in the four corners of the top cover of the 1780A.

4. Slide the top cover off.

5. Remove the screws in the four corners of the bottom cover of the 1780A.

6. Slide the bottom cover off.

7. To close the 1780A, slide the covers into the appropriate guides and fasten the eight screws.

Main PCB Access Procedure

Use the following procedure to remove or replace the Main PCB Assembly:

CAUTION

To avoid damaging static-sensitive MOS components on the Main PCB Assembly, observe the precautions on the Static Awareness Sheet.

1. Remove the bottom cover using the Interior Access Procedure.

CAUTION

To prevent damage to the Touch-Sensitive Overlay, disconnect the ribbon cable that connects the Touch-Sensitive Overlay to the Main PCB Assembly.

2. Disconnect the ribbon cable that connects the Touch-Sensitive Overlay to the Main PCB. Use the flat blade of a small screwdriver to carefully pull the connector straight out. Do not bend the contact pins.

3. Remove the four screws holding the Main PCB in place.

4. Fold the Main PCB out and down so that it rests on a clean, non-conductive bench surface. There is enough slack in the two remaining cables to allow this.

5. Carefully disconnect the remaining two cable connectors and remove the Main PCB.

6. Put the new Main PCB on the bench in the same position that the old one was in. Install the two cable connectors to the Power Supply and secure the CRT Electronics Assembly.

7. Fold the Main PCB into position in the 1780A, taking care not to damage the pins on the connector to the Touch-Sensitive Overlay.

8. Install the four screws that secure the Main PCB.

9. Connect the cable to the Touch-Sensitive Overlay, being careful not to bend the contact pins.

10. Put the top and bottom covers back on using the Interior Access Procedure.

11. Set the BAUD RATE switch to the desired number (see Section 2).

12. Connect line power and set the POWER switch to 1 (on).

13. Run the Performance Test in this section to verify correct operation of the new Main PCB.

CRT or Touch-Sensitive Overlay Access Procedure

Use the following procedure to remove the CRT or the Touch-Sensitive Overlay:

WARNING

TO AVOID INJURY, BE CAREFUL WHEN YOU HANDLE THE CRT. WEAR PROTECTIVE CLOTHING AND SAFETY GLASSES OR A FULL FACE SHIELD. AVOID STRIKING THE CRT ON ANY OBJECT. NEVER HANDLE THE CRT IN AN UNSAFE AREA, SUCH AS ONE WITH WET FLOORS, HIGH ACTIVITY, ETC. NEVER HANDLE THE CRT AROUND OTHERS WHO MAY NOT BE PROTECTED PROPERLY.

1. Remove the covers using the Interior Access procedure.

2. Disconnect the ribbon cable that connects the Touch-Sensitive Overlay to the Main PCB. Use the flat blade of a small screwdriver to carefully pull the connector straight out. Do not bend the contact pins.

CAUTION

Both the CRT anode and the high-voltage supply might retain a high-voltage charge after the InfoTouch Display has been turned off for some time. In the case of the CRT anode, this charge can build back up even after being discharged by the procedure that follows. Although not containing enough energy to be harmful, the charge could deliver a shock that could cause the CRT to be dropped.

3. Discharge the high-voltage charge through a 1 kilohm resistor as follows:

   a. Connect one end of the resistor to the chassis with one clip lead.

   b. Connect the other end of the resistor to the shaft of the 9 inch screwdriver (with the 1/4 inch tip), using the other clip lead.

c. Hold the screwdriver by its plastic handle and gently slip it under the edge of the plastic nipple on the CRT end of the high-voltage lead; keep the blade flat against the glass envelope. Slide the blade forward until the screwdriver blade touches the metallic clip at the end of the high-voltage lead. Be careful not to scratch the surface of the CRT.

4. Remove the High-Voltage lead from the side of the CRT as follows:

   a. Grasp the rubber insulating nipple firmly and slide it sideways against the tension of the wire prongs that are inside the nipple. This should unlock the connector.

   b. Pull the nipple outwards while maintaining the sideways pressure to remove the connector.

   c. Do not touch the anode button where the High-Voltage lead was attached to the CRT or the anti-corona spray surrounding the button.

5. Remove the rear connector from the base end of the CRT neck.

6. Disconnect the yoke signal cable from the video drive PWB mounted above the CRT.

7. Remove the side decals from the front corners of the front panel. New decals are provided in the kit for the new CRT.

8. Remove the two screws that hold each of the front corners of the front panel to the sides of the InfoTouch Display.

9. Gently pull the front panel toward you until the neck of the CRT is free of the chassis.

10. Set the front panel face down on a clear area of the bench with the neck of the CRT pointing up.

WARNING

TO AVOID INJURY, WEAR THE PROTECTIVE CLOTHING DESCRIBED IN TABLE 6-1 WHILE HANDLING THE CRT.

11. Put on the following protective clothing:

    a. Full face shield (preferred) or protective goggles.

    b. Long sleeved jacket.

    c. Protective gloves.

WARNING

THE CRT SUPPORT BRACKETS ARE SPRING LOADED. RESTRAIN THE BRACKETS WITH ONE HAND WHILE REMOVING THE SCREWS.

12. Remove the four screws from the CRT support brackets.

13. Remove the support brackets.

14. Grasp the CRT on each side of the bulb. Lift it straight up, being careful to leave the face pointing down. Do not strike it against anything.

15. Gently place the CRT face-down on a soft pad in a clear, protected area of the bench. The purpose of this pad is to prevent scratching of the face of the CRT and to avoid placing the CRT on a hard surface.

16. The Touch-Sensitive Overlay is now accessible.

17. Replace the new CRT or Touch-Sensitive Overlay as follows:

    a. If the Touch-Sensitive Overlay is being replaced, complete the following steps:

        1) Lift the old Touch-Sensitive Overlay out of the front panel. Note the cable routing.

        2) Unpack the new Touch-Sensitive Overlay.

        3) Install the new Touch-Sensitive Overlay with the cable routed in the same position as the old Touch-Sensitive Overlay.

    b. If the CRT is being replaced, complete the following steps:

        1) Put on your protective clothing.

        2) Unpack the new CRT as follows:

            a) Remove the protective cover from the base of the CRT.

            b) Hold the CRT by the bulb, curling your fingers around the edges onto the face.

            c) Place the CRT face down into the front panel with the socket for the High-Voltage lead towards the left (as seen from the front of the 1780A).

d) If the old CRT is going to be returned to factory, pack it in the shipping container in which the new CRT was received. To avoid damaging the old assembly, use the same precautions when handling the old CRT as you used when handling the new CRT.

WARNING

THE VACUUM WITHIN THE CRT ENVELOPE CONSTITUTES AN IMPLOSION HAZARD. IF THE OLD CRT IS NOT GOING TO BE RETURNED TO THE FACTORY, DISPOSE OF IT IN A SAFE MANNER. DO NOT DISCARD THE CRT WHERE IT MAY BE BROKEN ACCIDENTLY.

18. Install the CRT support brackets and the four screws that secure the CRT to the front panel. Be sure to reconnect the green grounding wire to the upper left corner of the CRT mounting bracket by ensuring that the mounting screw passes through the grounding wire's terminal lug. Do not over tighten the screws.

19. Observe that each of the front corners of the front panel has guides that are meant to accommodate notches that are in the sheet metal sides of the 1780A. Carefully rotate the front panel away from you to place it in the correct relative position that allows you to reinstall it into the 1780A. The guides on each side of the front panel should be directly in line with the notches in the sheet metal guides.

WARNING

TO PREVENT SHOCK HAZARD ON THE SURFACE OF THE CRT, INSURE THAT THE GROUND SPRING MAKES CONTACT. IF THE GROUND SPRING DOES NOT MAKE CONTACT, THE SURFACE OF THE CRT WILL BE AT ABOUT A 14KV POTENTIAL WHEN THE 1780A IS TURNED ON.

20. Move the front panel towards the 1780A, being careful that the sheet metal notches correctly enter the guides on each side of the front panel. Continue this movement until the Front Panel is all the way onto the 1780A and the guides are all the way into the notches. The holes in the Front Panel corners should match up with the corresponding holes in the sheet metal sides. Ensure that the ground spring is making proper contact with the outside of the CRT.

21. Install the two screws that hold each corner of the front panel to the 1780A.

22. Replace the side decals on the corners of the front panel. New decals are provided in the kit for the CRT.

23. Reconnect the yoke signal cable to the video drive PWB connector J102.

24. Attach the rear connector to the socket end of the CRT.

25. Connect the High-Voltage lead on the side of the CRT by grasping the rubber insulating nipple firmly and pressing the anode connector firmly into the socket on the side of the CRT.

26. Use the Main PCB Access Procedure to close up the 1780A.

27. If the CRT was replaced, complete the CRT Electronics Assembly Calibration Procedure.

CRT Electronics/Video Drive Assembly Access Procedure

The following procedure describes how to remove and replace the CRT Electronics Assembly. Refer to Figure 9-1 while performing these steps.

1. Remove the four screws securing the top cover. Then remove the top cover.

2. Verify that the CRT is discharged by performing the discharge procedure described in step 3 of the "CRT or Touch-Sensitive Overlay Access Procedure."

3. Remove the high-voltage lead from the CRT body by compressing the connector body. This method forces the wire prongs together, allowing for pulling the connector away from the CRT body. Do not touch the anode button (high-voltage lead to CRT connection point) or the anti-corona spray surrounding this button.

4. Remove the two screws holding the CRT Electronics PWB to the mounting catch plate. The CRT Electronics PWB is now free to hinge upward.

5. Swing the CRT Electronics PWB upward and disconnect the power cable (J103), the yoke cable (J102), and the video signal cable (J106).

6. Remove the two screws attaching the CRT Electronics PWB to the hinges. Retain the insulation plate for future use.

7. With the insulation plate first slipped over the hinge bodies, use the two screws removed in the previous step to attach the new CRT Electronics PWB to the hinges.

8. Reconnect the video signal cable (J106), the yoke cable (J102), and the power cable (J103).

9. Secure the CRT Electronics PWB to the catch plate with the two screws removed in step 4.

10. Reconnect the high-voltage lead to the CRT by compressing the connector body. This forces the pins together and allows for pressing the connector into the CRT body.

11. Verify that all previous steps have been performed and that all screws and connections are tight. Then replace the top cover and secure the four screws removed in step 1.

NOTE

For proper operation, alignment is required after installation of a new CRT Electronics PWB. This procedure is provided later in this section.

Character EPROM Access Procedure

To remove and install the Character EPROM, proceed as follows:

CAUTION

To avoid damaging static-sensitive MOS components such as the Character EPROM, observe the precautions outlined on the Static Awareness sheet when removing or replacing EPROMs.

1. Remove the Main PCB Assembly using the Main PCB Access Procedure.

2. Locate the Character EPROM, U32.

3. Use a 24-Pin IC extractor to remove the EPROM, being careful not to bend the contact pins. Store the removed EPROM in an appropriate anti-static container.

4. Insert the new PROM into the sockets with care, making sure that:

   a. The PROM is oriented correctly with the locating key on the IC package in the same position as shown in the Assembly drawing.

   b. No IC pin is bent or outside its hole.

5. Close the 1780A up using the Main PCB Access Procedure.

6. Complete the Performance Tests.

PERFORMANCE TESTS

Introduction

The Performance Tests verify correct operation of the 1780A. To ensure that the 1780A is operating correctly, run the Performance Tests every 90 days, or after maintenance is performed. The Performance Tests use the Local Test Mode to verify most 1780A functions. Be sure to perform the Serial Port Readback Test last.

The Performance Tests can be executed without removing the covers from the InfoTouch Display. The only tools required are the RS-232-C Loopback Connector (see Table 6-1) and a small screwdriver.

Performance Test Procedure -- Local Test Mode

The Local Test Mode is enabled or disabled by the TEST MODE FUNCTION switch on the rear panel of the 1780A. After the 1780A is in the Local Test Mode, there are five tests available. These tests are selected using the BAUD RATE switch on the rear panel. Use the following steps to perform the Performance Test using the Local Test Mode:

NOTE

The first portion of the Performance Test uses the Self Test program to verify correct operation of the CPU and internal memory. The Self Test program runs only when the POWER switch is set to 1 (on). If there are any obvious faults with the 1780A, such as a faulty display (out of focus, unstable, etc.) or incorrect operation, refer to the Troubleshooting material later in this section instead of proceeding with this Performance Test.

1. Complete the following steps to perform the Power Up Self Test:

   a. Set the POWER switch to 1 (on).

   b. Observe the red ACTIVITY LED through the opening on the rear panel.

      1) The indicator lights for a few seconds while the the Self Test program is running.

      2) If the ACTIVITY LED turns off, the Self Test program did not detect any faults. Continue with this Performance Test.

      3) If the ACTIVITY LED stays on, the Self Test program detected a fault(s).

         a) "ROM Err" is displayed in blinking reverse-video if a ROM error is detected.

         b) "RAM Err" is displayed in blinking reverse-video if a RAM error is detected.

         c) Depending upon the actual ROM or RAM error, you may be able to operate the 1780A with no noticeable problems. If you do have problems, the Main PCB may be bad. Refer to the Troubleshooting material later in this section for help.

2. Complete the following steps to perform the Video Alignment Verification:

   a. Set the TEST MODE FUNCTION switch to ON to select the Local Test Mode.

   b. Note the baud rate that is selected by the BAUD RATE switch. You will need to return the switch to this position after this test.

   c. After allowing the 1780A to warm up for about 10 minutes, set the BAUD RATE switch to the 0 position to enable the Video Alignment Verification Pattern.

   d. The Touch-Sensitive Overlay isolation lines (barely visible lines) should line up in the spaces between the square brackets (][) of the displayed pattern.

   At normal operating temperatures ($25^{o}C \pm 5^{o}C$) the vertical isolation lines should be within one character and the horizontal isolation lines should be within one-half of a character at the reference marks on the displayed pattern.

   e. If the display is out of alignment, go to the CRT Electronics Assembly Calibration Procedure for directions on aligning the display.

   f. If the display is not out of alignment, continue with this procedure.

3. Complete the following steps to perform the Character Set Verification:

   a. Set the BAUD RATE switch to position 3 to display the entire character set in double-size characters.

   b. Verify that the characters agree with the standard character set specification shown in Section 4. If an alternate character set is used, verify that the displayed character set agrees with the specification for that character set.

      1) If there are incorrect characters, the Character EPROM is defective. Go to the Character EPROM Access procedure for help in changing the EPROM.

      2) If the characters are correct, continue with this procedure.

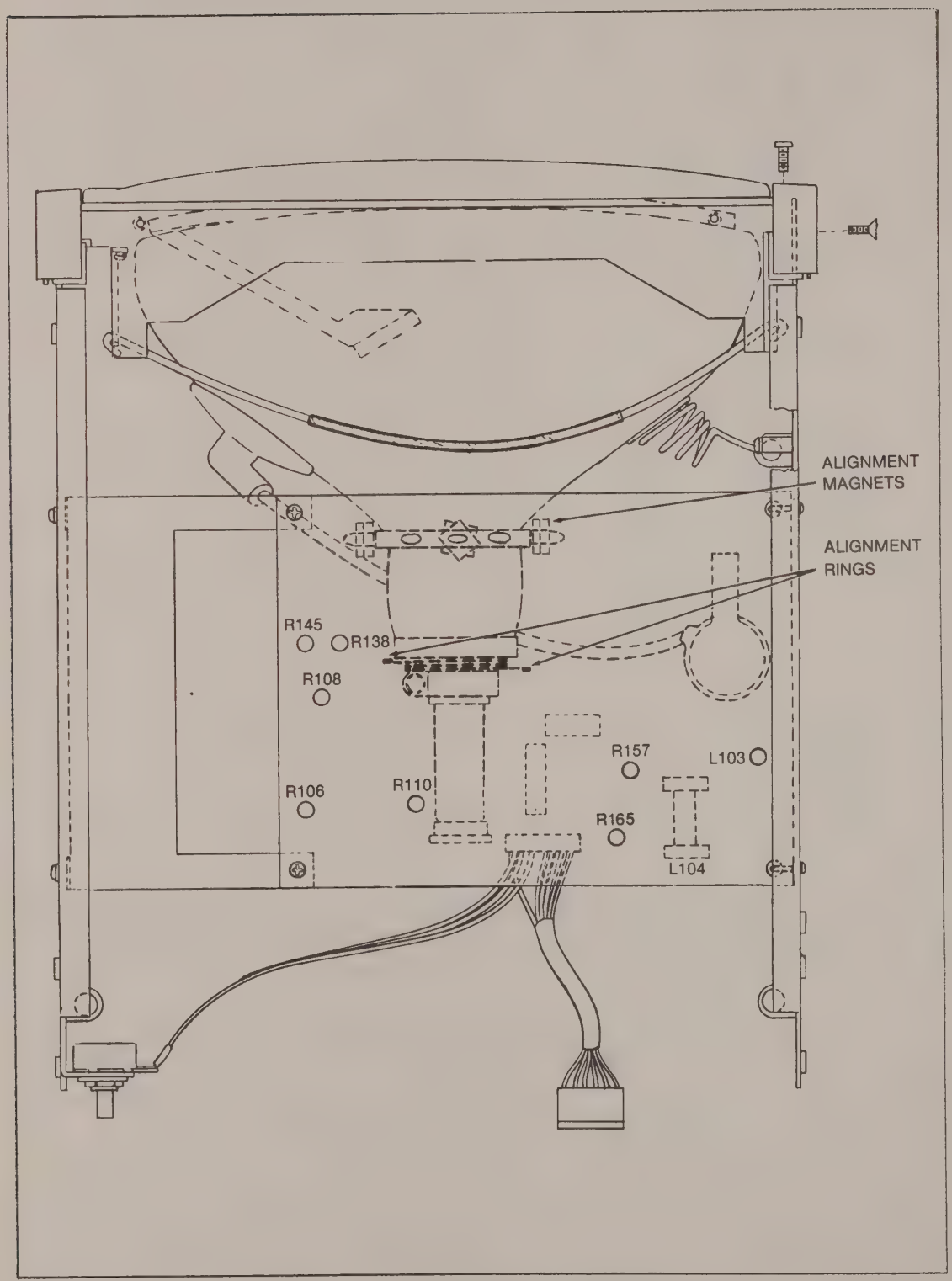

Figure 6-1. Adjustment Locations

4. Complete the following steps to verify proper operation of the Touch-Sensitive Overlay:

   a. Set the BAUD RATE switch to position 4 to select the Touch-Sensitive Overlay Test.

   b. Press each Touch-Sense Key in the following sequence:

      1) Start at the upper left corner.

      2) Proceed horizontally to the right.

      3) Return to the left side to begin pressing the next row of Touch-Sense Keys.

   c. Verify that an * appears at the Touch-Sense Key positions as each key is pressed.

5. Complete the following steps to perform the Keyboard Loopback Test. This test requires a Y1720 Programmer Keyboard and a Keyboard Interface. If you do not have this accessory and this option, proceed to the next test.

NOTE

The next part of the Performance Test uses the RS-232-C Loopback Connector and a Keyboard Interface to return the output of the 1780A back to its input for display. Use the Y1720 to generate outputs and watch the display to see if the correct characters are returned and displayed. This is equivalent to local operation but has the added benefit of checking serial port communication.

   a. Disconnect the RS-232-C connector on the rear panel and install the RS-232-C Loopback Connector.

   b. Set the TEST MODE FUNCTION switch to OFF to return the 1780A to normal operation.

   c. Press the Y1720 keys and check that the correct character is displayed. Refer to Table 4-2.

      1) If the keys do not produce the correct results, go to the Troubleshooting procedure in this section.

      2) If the keys produce the correct characters, the 1780A is fully functional and ready for operation.

6. Set the POWER switch to 0 (off).

7. Remove the RS-232-C Loopback Connector and replace the normal RS-232-C connector.

8. Set the BAUD RATE switch to the position noted in Step 2.c.

Performance Test Procedure -- Remote Test Mode

The following procedure verifies communication between the host computer and the 1780A. This test consists of asking for the cursor position and verifying that the cursor position was indeed reported correctly. Complete the following steps:

1. Send <ESC> [1 ; 1 H to the 1780A to place the cursor at column 1, row 1. This is the home position.

2. Send <ESC> [6 n to request the current position of the cursor.

3. Verify that the 1780A replies with <ESC> [1 ; 1 R.

CALIBRATION PROCEDURE

Introduction

There are two calibration procedures: the Power Supply Calibration Procedure and the CRT Electronics Assembly Calibration Procedure. These procedures are independent of one another.

Power Supply Calibration Procedure

The power supply has one adjustment. This adjustment sets the 12V video supply. Use the following procedure to adjust the 12V video supply:

1. Access the Main PWB using the Main PWB Access Procedure.

2. Monitor the output voltage at TP3 (+) with respect to TP1 (-).

3. Adjust the 12V adjustment (R27) until TP3 measures 12V $\pm$0.1V.

4. If R27 cannot adjust the 12V supply within tolerance, replace the Main PCB Assembly.

CRT Electronics Assembly Calibration Procedure

WARNING

USE EXTREME CARE WHEN MAKING ADJUSTMENTS TO THE VIDEO CIRCUITRY. DANGEROUS HIGH VOLTAGES EXIST IN THE VIDEO DRIVE CIRCUITRY. THIS PROCEDURE SHOULD BE PERFORMED BY QUALIFIED PERSONNEL ONLY. ENSURE THAT SAFETY CLOTHING CALLED FOR IN TABLE 6-1 IS BEING USED BEFORE CONTINUING

NOTE

This factory adjustment procedure is not normally required, but the procedure can be used as reference material whenever the display needs adjustment.

This procedure is used after either the CRT Electronics Assembly or the CRT has been replaced. The procedure can be used as reference material whenever the display needs alignment. The video alignment portion of the procedure uses an alignment pattern that is generated by the 1780A in the Local Test Mode. Most of the adjustments needed in this procedure are located on the Video Electronics Assembly and are accessible through holes in the insulation plate below the top cover. Refer to Figure 6-1 for adjustment locations.

NOTE

Display alignment is affected by temperature, supply voltage, brightness, and external magnetic fields. Consider these influences before making alignment corrections.

Complete the foll wing steps to align the display:

1. Remove the top and bottom covers using the Interior Access procedure.

2. Set the POWER switch to 1 (on), and allow the 1780A to warm up to normal operating temperature (at least 30 minutes).

3. Using a DVM, verify that the Video Supply Voltage, TP3 (+) to TP1 (-), is 12V $\pm$0.1V. If the voltage is not within the indicated tolerance, complete the Power Supply Calibration Procedure before continuing with these steps.

4. Complete the following steps to enable the video alignment pattern:

   a. Set the TEST MODE FUNCTION switch to ON.

   b. Note the position of the BAUD RATE switch. It must be returned to this position after completing the Calibration Procedure.

   c. Set the BAUD RATE switch to the #0 position. The Video Alignment Pattern (Figure 6-2) is displayed.

   d. With proper alignment, the Touch-Sensitive Overlay isolation lines will be between the square bracket reference marks. At operating temperature (25 $\pm5^{\circ}$C), the vertical isolation lines should be within one character and the horizontal isolation lines should be within half a character.

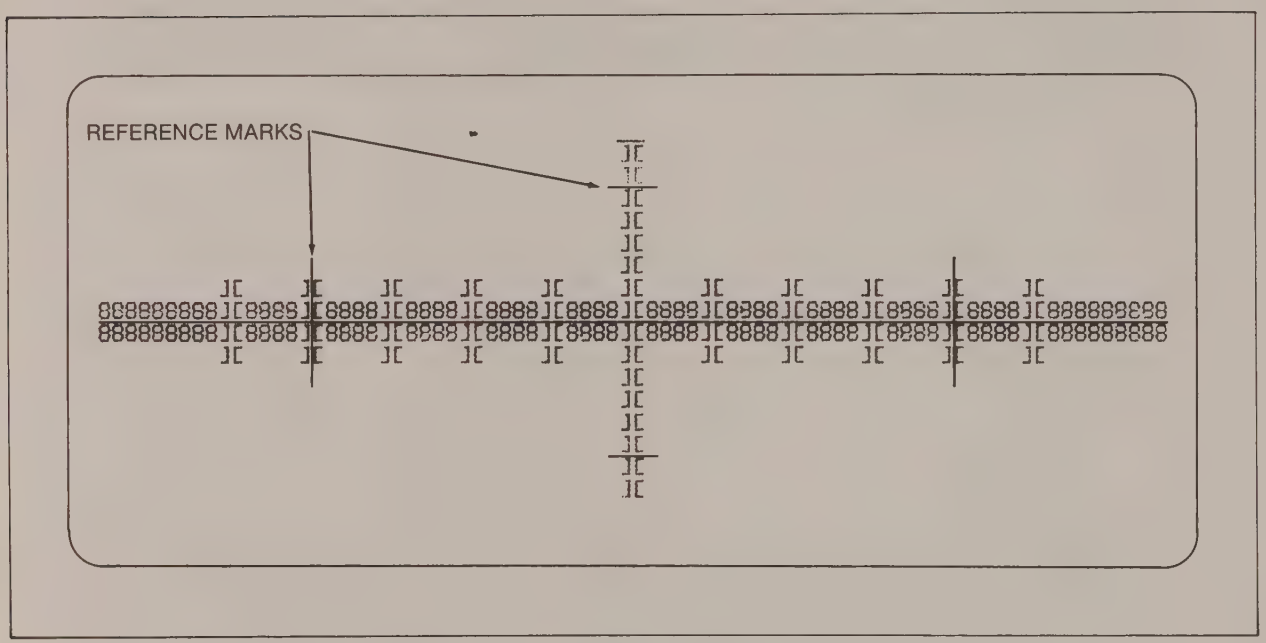

Figure 6-2. Video Alignment Pattern

5. If necessary, complete the following steps to adjust the Master Brightness Control (R165).

   a. Turn the Brightness Adjustment pot on the 1780A rear panel fully clockwise.

   b. Increase the Master Brightness pot (R165) on the Video Electronics Assembly to its maximum brightness. Then decrease the brightness until the background raster is no longer visible.

   c. With the Master Brightness set, the display brightness can be adjusted to a comfortable level using the rear panel adjustment pot.

6. Perform the following steps to center the entire video display area with respect to the CRT TUBE face:

   a. Turn the Master Brightness control to full intensity. This causes the scan raster to appear and illuminate the entire video display area.

   b. Adjust the Yoke video rings located on the rear of the CRT yoke until the brightly glowing display region on the tube is roughly centered with respect to the face of the tube.

   c. Turn the Horizontal Hold pot (R145) fully clockwise. This shifts the displayed pattern to the left of the screen.

   d. If necessary, adjust the Horizontal Centering pot (R138) to move the left side of the pattern back into view on the left side of the screen. Temporarily mark this left side position on the screen.

   e. Again using the Horizontal Hold pot (R165), shift the displayed pattern to the right until the display loses stability. Now reverse the R165 adjustment enough to shift the pattern one-half the distance to the mark made in the previous step.

   f. This completes the Display initial centering. Return the Master Brightness Control (R165) to a level just below background raster visibility.

7. Center the Alignment Tool on the front screen of the 1780A.

8. Adjust the Focus Control pot (R157) to optimize pixel resolution at the center of the displayed screen.

9. Perform the following steps to complete the centering of the video display:

   a. Physically rotate the yoke until the horizontal line of displayed characters is as closely aligned as possible with the horizontal bar on the alignment tool.

   b. Secure the yoke in position by tightening the clamp at the rear of the yoke to six inch-pounds.

   c. Again adjust the yoke video alignment rings at the rear of the yoke to horizontally and vertically align the center of the displayed region as close as possible to the alignment tool. Disregard image alignment in the corners.

   d. Using the Right Side adjustment (L104), stretch the right boundary of the displayed image to line up with the right side marking on the alignment tool.

   NOTE

   Access to L103 can only be gained by first removing the two screws that secure the Video Electronics PWB to the catch plate and then swinging the Video Electronics PWB up on it's mounting hinges.

   e. Using the Left Side Linearity adjustment (L103), stretch the left side of the displayed image 1/2 of the way to the left side marking on the video alignment tool.

   NOTE

   Repeat steps c, d, and e as necessary to obtain adequate centering and alignment of the center section of the displayed image.

10. Perform the following steps to make boundary image corrections:

   a. Using the Height adjustment pot (R108), stretch the upper edge of the displayed pattern until it is aligned with the upper edge of the alignment tool. Disregard image alignment in the corners.

   b. Using the Vertical Linearity pot (R110), pull the bottom portion of the displayed pattern down until it is aligned with the bottom mark on the alignment tool.

   NOTE

   Repeat steps a and b as necessary to obtain adequate boundary centering and linearity.

11. Corrections to the image displayed in the corners of the screen are made by securing correction magnets to the corresponding studs on the yoke. If a particular corner of the display needs, alignment, place a correction magnet on the nearest corresponding stud on the yoke. Press the correction magnet firmly on the stud and rotate the magnet until the desired effect is realized.

NOTE

A corner stud may require multiple magnets to yield acceptable alignment.

12. Minor adjustments might still be required to achieve the desired alignment. Any one of the specific adjustments (Vertical Linearity - R110, Horizontal Centering - R138, etc) can be adjusted slightly to correct the overall alignment. However, any large-scale change could necessitate a total realignment.

TROUBLESHOOTING

Introduction

Follow the steps in the sequence presented to isolate faults to a module level. The Access Procedures provides directions for replacing major components. Always run the Performance Test procedure after performing any diagnostic task.

General Fault Isolation

The General Fault Isolation procedure below lists steps to follow while diagnosing unknown faults in the 1780A. If you are trying to diagnose faults with obvious symptoms, you may bypass these steps and go directly to specific procedures.

1. If you are trying to diagnose obvious Touch-Sensitive Overlay problems, go to Touch-Sensitive Overlay Diagnosis.

2. If you are trying to diagnose Video problems, or any other problems, continue with this procedure.

3. Set the POWER switch to 1 (on).

   a. If there is no audible beep, go to the Power Supply Verification procedure.

   b. If there is an audible beep, continue with this procedure.

4. Verify that a cursor is visible on the display.

   a. If no cursor is visible, go to the Power Supply Verification procedure.

   b. If there is a cursor visible, but it's unstable (rolling, etc.), go to the CRT Electronics Assembly Verification procedure.

   c. If there is a cursor visible, continue with this procedure.

NOTE

The next step uses the results of a Self Test program, which is contained internally in the 1780A and is executed during each power- on sequence to determine whether faults exist on the Main PCB. The Self Test program verifies proper operation of the CPU, internal memory, the CRT Controller, and the RS-232-C interface.

5. Watch the red ACTIVITY LED (visible through a rear panel opening.) Allow a few seconds for the Self Test program to execute. After the Self Test is complete, the internal program loop causes the ACTIVITY LED to blink on and off. If a memory failure occurs the LED remains on. Any failure mode that stops the program from looping leaves the LED either on or off, depending on the amount of program execution.

   a. If the ACTIVITY LED does not flash after power-up, replace the Main PCB. Refer to the appropriate Access Procedure.

   b. If the ACTIVITY LED continues to flash, proceed to the CRT Electronics Assembly Verification procedure.

   c. Disregard the ACTIVITY LED when the TEST MODE FUNCTION is ON. The ACTIVITY LED may be on or off.

Power Supply Verification

The Power Supply Verification procedure assumes that your 1780A does not beep during the power-on sequence or has no visible cursor. Most of the Power Supply circuitry is contained on the Main PCB. Therefore, most Power Supply faults can be solved by changing the Main PCB. Some Power Supply components, the primary circuit components, are mounted on the Rear Panel Assembly.

Complete the following steps to verify correct power supply operation or to diagnose power supply faults:

1. Check that the line power is correct for the value selected. See the Line Power Fuse Replacement and Voltage Select Procedure in Section 2 for help in verifying that the correct line voltage is selected.

   a. If the selected voltage is wrong, select the correct voltage and go back to General Fault Isolation.

   b. If the selected voltage is correct, continue with this procedure.

2. Verify that the rear panel line power fuse is the correct type and is not open. See the Line Power Fuse Replacement and Voltage Selection Procedure in Section 2 in verifying that the fuse is the correct type.

   a. If the fuse is the correct size and open, go to Open Fuse Diagnosis.

   b. If the fuse is not open, continue with this procedure.

3. Verify that the 1780A is plugged in.

4. Verify that the POWER switch is at 1 (on).

5. Verify that the INTENSITY control is not turned down to minimum.

6. If you find a problem with any of the previous conditions (not plugged in, switch off, etc.), correct the problem and run the Performance Test. If no problems have been detected up until this point, continue with this procedure.

7. Remove the Main PCB using the Main PCB Access Procedure.

8. Set the POWER switch to 1 (on).

9. Verify that all of the indicated voltages are present at the Power Test header, J2. See the Main PCB Assembly drawing in Section 9 for component location. The header voltages are marked on the Main PCB.

   a. If the +5, +12, or -12V voltages are not correct, go to Primary Circuit Verification.

   b. If the 12V UNRG line does not show a voltage of at least 16V, continue with this section.

   c. If all the voltages are correct, the power supply is working correctly.

10. Disconnect Connector J3 and monitor the video signals at pins 2,4 and 5 with a logic probe.

    a. If all three lines are active, go to CRT Electronics Assembly Verification procedure.

    b. If one or more of the three lines is not active, replace the Main PCB. Refer to the appropriate Access Procedure. The three lines are the video output to the monitor. Inactivity results from a bad component on the Main PCB.

11. Use the following procedure if the 12V UNRG supply cannot be verified. Part "a" covers a low or missing voltage, and Part "b" covers an out-of-tolerance voltage that can be adjusted.

    a. If the 12V Video Supply (measured at TP3) is very low or missing, complete the following steps:

        1) Disconnect connector J3 to isolate the load from the 12V Video Supply.

        2) Measure the 12V supply at TP3.

            a) If the voltage measures 12V±1V, go to the CRT Electronics Assembly Fault Diagnosis section. The CRT Electronics Assembly is at fault and should be replaced.

            b) If the 12V supply is still missing or is very low, go to the Primary Circuit Verification Procedure.

CAUTION

When installing a new Main PCB after diagnosing a bad 12V Video Supply, monitor the 12V Video Supply with a DVM. If the 12V Video Supply drops immediately when the 1780A is turned on, turn the power off and replace the CRT Electronics Video Drive Assembly. A bad monitor may have damaged the 12V Video Supply.

    b. If the 12V Video Supply appears to be out of tolerance, complete the Power Supply Calibration Procedure. If this procedure cannot bring the 12V Video Supply to 12V±0.1V, replace the Main PWB.

    c. If the Calibration Procedure did properly set the 12V Video Supply, connect J3 and complete the Performance Test.

Primary Circuit Verification

Use this procedure to determine whether erroneous or missing voltages are the result of defective components in the primary circuit. You should be entering this procedure after determining that voltages were missing. Follow these steps:

1. Set the POWER switch to 0 (off).

2. Remove connector J4 from the Main PCB.

3. Set the POWER switch to 1 (on).

4. Use the DVM to measure the AC voltages at J4 as follows:

   Pin 2 to pin 4 => 23V
   Pin 1 to pin 6 => 10V
   Pin 2 to pin 6 => 10V
   Pin 5 to pin 6 => 19V

5. If any of the voltages are not present or are not within ±10% of the correct value, a defective primary component is indicated. Contact your local Fluke Service Center for advice.

6. If all of the voltages are correct, the Main PCB is defective. Replace the Main PCB.

Open Fuse Diagnosis

You should be entering this procedure from step 2 of the Power Supply Verification procedure after determining that there is an open power line fuse. Use the following procedure to isolate the source of the fault:

1. Go to the next step if there is no keyboard accessory connected to the 1780A. If there is a keyboard accessory connected, complete the following steps:

   a. Set the POWER switch to 0 (off).

   b. Disconnect the keyboard.

   c. Install a new fuse (see Section 2 for the procedure).

   d. Set the POWER switch to 1 (on).

      1) If the power line fuse does not open, replace the keyboard.

      2) If the power line fuse opens again, continue with this procedure.

2. Disconnect J3 on the Main PCB to eliminate the 12V Video load.

3. Monitor the 12V Video Supply with a DVM at TP3 on the Main PWB.

   a. If the 12V Video Supply is 12 ±1V, replace the CRT Electronics Assembly.

   b. If the 12V supply is not 12 ±0.1V, replace the Main PWB.

Video Verification

You should be entering this section if you suspect video problems or have verified that the Power Supply is not faulty. Use this procedure to verify that the video portion of the Main PCB is operating correctly. Refer to Figure 6-1 for the Video Component Locations.

1. Set the POWER switch to 0 (off).

2. Set the TEST MODE FUNCTION switch to ON.

3. Set the POWER switch to 1 (on).

4. Turn the BAUD RATE switch to #3 to display the complete character set in double-size characters.

   a. If the character display is normal, the video circuit is performing correctly. Go to the Touch-Sensitive Overlay Verification.

   b. If characters appear but have a vertical roll, then go to Vertical Roll Diagnosis.

   c. If characters appear but have a horizontal roll (a horizontal drift or a tearing effect), go to the Horizontal Roll Diagnosis.

   d. If the background raster is visible, covering the entire display area with light, go to Bright Display Diagnosis.

   e. If no characters appear, then turn the INTENSITY control fully CW.

      1) If no characters appear, return the INTENSITY control to its original position and continue with this procedure.

      2) If characters do appear, adjust the INTENSITY control for normal viewing and run the Performance Test.

5. If characters do not appear on the display, the fault can be either the video portion of the Main PCB or the CRT Electronics Assembly. Complete the following steps to isolate the fault:

   a. Set the TEST MODE FUNCTION switch to ON.

   b. Note the position of the BAUD RATE switch.

CAUTION

To prevent the CRT face from being burned, stop the following test quickly by turning the BAUD RATE switch to any other position if anything but a full screen display occurs.

   c. Turn the BAUD RATE switch to #2 to enable the Inverse Video Test.

      1) If a full, bright, flickering raster appears, then the video circuitry on the Main PCB is functioning correctly. Go to the CRT Electronics Assembly Diagnosis procedure.

      2) If the display is other than a full, bright flickering raster, the Main PCB is bad. Replace the Main PCB.

CRT Electronics Assembly Diagnosis

This procedure determines which submodule within the CRT Electronics Assembly (consisting of the CRT, the CRT Electronics, and the High-Voltage Module) of the 1780A is defective. You should be entering this step after having determined that the CRT Electronics Assembly is not operating properly.

1. If you see a blank display, go to Step 4 of this procedure.

2. If you see a horizontal line, go to Step 6 of this procedure.

3. If you don't see any of the above, then contact your local Fluke Service Center.

4. Complete the following procedure to determine if the display is blank because of a bad filament:

WARNING

HIGH VOLTAGE IS PRESENT WITHIN THE CRT AREA. TO PREVENT AN ELECTRICAL SHOCK HAZARD DO NOT PLACE HANDS OR METALLIC OBJECTS INTO THIS AREA.

   a. Look at the clear glass neck of the CRT, just ahead of the plastic socket.

b. Locate the filament (glowing brightly).

1) If you can see the filament glowing and there is no blue glow from the neck area of the CRT, you can assume that the CRT is good and the CRT Electronics Assembly must be replaced then run the Performance Test.

2) If you can see a blue glow in the neck area of the CRT, the CRT is gassy and it must be replaced. Replace the CRT then run the Performance Test.

3) If you cannot see the filament glowing, then continue with this procedure.

5. Use the following procedure to isolate the fault if the filament is not glowing. Enter this step only if the filament is not glowing.

a. Set the POWER switch to 0 (off).

WARNING

A POSSIBILITY EXISTS THAT THE HIGH-VOLTAGE SUPPLY IS NOT DISCHARGED. TO PREVENT AN ELECTRICAL SHOCK HAZARD FOLLOW THE PROCEDURE OUTLINED IN ACCESS PROCEDURES FOR DISCHARGING THE HIGH-VOLTAGE SUPPLY BEFORE PROCEEDING.

b. After discharging the High-Voltage Supply, remove the socket from the base of the CRT.

c. Measure between pins 1 and 8 to check filament continuity. Five ohms is typical.

1) If the filament is open, the CRT is bad and must be replaced. Refer to the appropriate Access Procedures, especially the warning paragraph concerning the dangers involved with the process. Replace the CRT; restore the system to its normal configuration, and run the Performance Test.

2) If the filament is not open, continue with this procedure.

d. Measure the resistance in the horizontal yoke coil as follows:

1) With POWER OFF, disconnect the Yoke Signal Cable from the CRT Electronics PWB (J102).

2) Measure the resistance between the cable connector pin 3 and pin 5.

3) The resistance should be 7 ohms ±2 ohms.

a) If the reading is not correct, then the yoke is defective. The yoke and CRT are provided as a matched, pre-aligned set for servicing; therefore, the whole CRT Assembly must be replaced. Refer to the appropriate Access Procedure and replace the CRT Assembly. Carefully note the warning about the danger involved in handling the CRT. Following this, restore the 1780A to its normal configuration and run the Performance Test.

b) If the reading is correct, replace the Video Electronics Assembly. Refer to the appropriate Access Procedure. Following this action, run the Performance Test.

6. Use the following procedure to diagnose the cause of a horizontal line display. This condition is due to a fault in the vertical drive which can either be the yoke or the CRT electronics.

a. With POWER OFF, disconnect the Yoke Signal Cable from the CRT Electronics PWB (J102).

WARNING

HIGH VOLTAGE IS PRESENT WITHIN THE CRT AREA. TO PREVENT AN ELECTRICAL SHOCK HAZARD DO NOT PLACE YOUR HANDS OR METALLIC OBJECTS INTO THIS AREA.

b. Measure the resistance between the cable connector pin 1 and pin 2.

c. The resistance should be 10 ohms ±2 ohms.

1) If the reading is not correct, the yoke is defective. The yoke and CRT are provided as a matched, pre-aligned set for servicing, therefore, the CRT must be replaced. Replace the CRT assembly then restore the 1780A to its normal configuration. Run the Performance Test.

2) If the reading is correct then the CRT Electronics assembly is faulty. Replace the CRT Electronics Assembly and restore the system to its normal configuration. Run the Performance Test.

Vertical Roll Diagnosis

You should be entering this procedure from Video Verification. You have a display that has characters but displays them with a vertical roll. This problem is caused by a lack of vertical synchronization. The purpose of this step is to determine if the fault is in the video portion of the Main PCB or the CRT Electronics Assembly.

1. Use the Interior Access Procedure to remove the top cover.

WARNING

HIGH VOLTAGE IS PRESENT WITHIN THE CRT AREA. TO PREVENT AN ELECTRICAL HAZARD DO NOT PLACE YOUR HANDS OR METALLIC OBJECTS INTO THIS AREA.

2. Set up the oscilloscope as follows:

VERT single trace, 2V per cm.
SYNC internal, positive
HORZ as necessary

3. Disconnect Connector J3.

4. Set the POWER switch to 1 (on).

5. Place the scope probe on pin 2 of J3. You should be able to see positive-going TTL-level (4V approximate) pulses, approximately 190 us wide and 17 ms apart.

   a. If these pulses are present, then the CRT Electronics Assembly must be replaced. Replace the CRT Electronics and restore the system to its normal configuration. Run the Performance Test.

   b. If you do not see these pulses, disconnect the CRT Electronics Assembly from the system and look again using the following procedure:

      1) Remove the bottom cover using the Interior Access Procedure.

      2) Unplug the edge connector from the rear of the bottom CRT Electronics PCB.

      3) Disconnect Connector J3.

      4) Set the POWER switch to 1 (on). The display is blank with the connector removed.

5) Using the scope, look at pin 5 of J3.

a) If the pulses are there, replace the CRT Electronics Assembly and restore the system to its normal configuration. Run the Performance Test.

b) If the pulses are not there, replace the Main PCB and restore the system to its normal configuration. Run the Performance Test.

Horizontal Roll Diagnosis

You should be entering this Procedure from Video Verification. The display has characters but displays them with a horizontal roll that shows up as a tearing in the horizontal direction. This problem is caused by a lack of horizontal synchronization. The purpose of this step is to find out if the problem is in the video portion of the Main PCB or in the CRT Electronics Assembly.

1. Fold out the Main PCB using the Main PCB Access Procedure.

2. Disconnect Connector J3.

3. Set the POWER switch to 1 (on).

WARNING

HIGH VOLTAGE IS PRESENT WITHIN THE CRT AREA. TO PREVENT AN ELECTRICAL SHOCK HAZARD DO NOT PUT YOUR HANDS OR METALLIC IMPLEMENTS INTO THIS AREA.

4. Set up the oscilloscope as follows:

VERT 2V per cm.
SYNC internal, positive
HORZ as necessary

5. Place the scope probe on pin 2 of J3. You should be able to see positive-going TTL pulses (approximately 4V) that are approximately 4.5 us wide and 62 us apart.

a. If these pulses are present, replace the CRT Electronics Assembly and restore the system to its normal configuration. Run the Performance Test.

b. If you do not see these pulses, disconnect the CRT Electronics Assembly and look again using the following procedure:

1) Use the Interior Access Procedure to remove the top cover.

2) Unplug the edge connector from the rear of the bottom CRT Electronics PCB.

3) Set the POWER switch to 1 (on). The display is blank with the connector removed.

4) Using the scope, look at pin 5 on J3.

a) If the pulses are there, replace the CRT Electronics Assembly and restore the system to its normal configuration. Run the Performance Test.

b) If the pulses are not there, replace the Main PCB and restore the system to its normal configuration. Run the Performance Test.

Bright Display Diagnosis

You should be entering this procedure from Video Verification because the display is bright, covering the entire display area with light. The problem can be caused by a fault in the CRT (shorted elements) or in various areas of the CRT Electronics Assembly that provide the correct bias for the CRT. The purpose of this step is to find out if the problem is in the CRT itself or in the CRT Electronics.

1. Make a note of the position of the INTENSITY control. Turn this control CCW until the background raster just disappears.

a. If the background raster will extinguish, return to the beginning of Video Verification.

b. If the background raster will not extinguish, return the control to its original position and continue with this procedure.

2. Set the POWER switch to 0 (off).

WARNING

A POSSIBILITY EXISTS THAT THE HIGH-VOLTAGE SUPPLY IS NOT DISCHARGED. TO PREVENT AN ELECTRICAL SHOCK HAZARD, FOLLOW THE PROCEDURE OUTLINED IN ACCESS PROCEDURES FOR DISCHARGING THE HIGH-VOLTAGE SUPPLY BEFORE PROCEEDING.

3. Remove the tube socket from the base of the CRT.

4. Set up the oscilloscope (or use a DVM) as follows:

   VERT 10V per cm., DC coupled
   SYNC Auto
   HORZ 1 ms/cm

5. Set the POWER switch to 1 (on).

6. Measure the voltage at the center tap of the rear panel INTENSITY control. The voltage should be -2V ±2V (i.e., -4V to +0V). If the original setting is not certain, verify that the adjustment range is at least -50V to +10V.

7. Measure the voltage at the yellow lead to the CRT socket at the PWB end of the lead. This voltage should be approximately 50V ±10V.

8. Measure the voltage at the red lead to the CRT socket at the PWB end of the lead. This voltage should measure approximately 500 volts ±50 volts.

9. If the voltages called for in steps 6, 7, and 8 are correct then the CRT is probably defective and should be replaced. If any of the voltages are incorrect then replace the CRT Electronics Video Drive Assembly.

Touch-Sensitive Overlay Verification

You should be entering this test if you suspect that there is a bad Touch-Sensitive Overlay. To verify correct operation of the Touch-Sensitive Overlay, use the following procedure:

1. Turn the TEST MODE FUNCTION switch on the rear panel to ON.

2. Turn the BAUD RATE switch to #4 to select the Touch Panel Test.

3. Touch all of the Touch-Sense Keys from left to right and top to bottom starting at the upper left corner of the Touch-Sensitive Overlay. When a Touch-Sense Key is touched, an X appears at that key location to signify correct operation. Touch all of the keys and verify that an X appears for each one.

   a. If none of the keys work, verify that the Touch-Sensitive Overlay is connected to the Main PCB.

      1) If the Touch-Sensitive Overlay is connected, replace the Main PCB.

      2) If the Touch-Sensitive Overlay is not connected, plug it in and run the Performance Test.

   b. If any key does not work, the test will not continue. Use the following procedure to determine whether the Touch-Sensitive Overlay or the Main PCB is at fault.

      1) Disconnect connector J1 on the Main PCB.

      2) Use the DVM to measure the resistance between the bad row and any other column (while that key is touched) or between the bad column and any other row as appropriate. Refer to Figure 6-3 for pin identification on J1. The resistance should measure less than 2 kilohms.

         Example: None of the keys on Row 3 work. Measure the resistance between the contact pin for Row 3, pin 13 on J1 to any column while touching the key that they monitor -- it doesn't matter which column is used. In this example, Column 2 is used (pin 9 on J1). The key where Row 3 and Column 2 intersect is touched -- Key 22. Refer to Section 4 or a Programmer's Worksheet for key identification.

         a) If the switch measures greater than 2 kilohms, replace the Touch-Sensitive Overlay.

         b) If the switch measures 2 kilohms or less, replace the Main PCB.

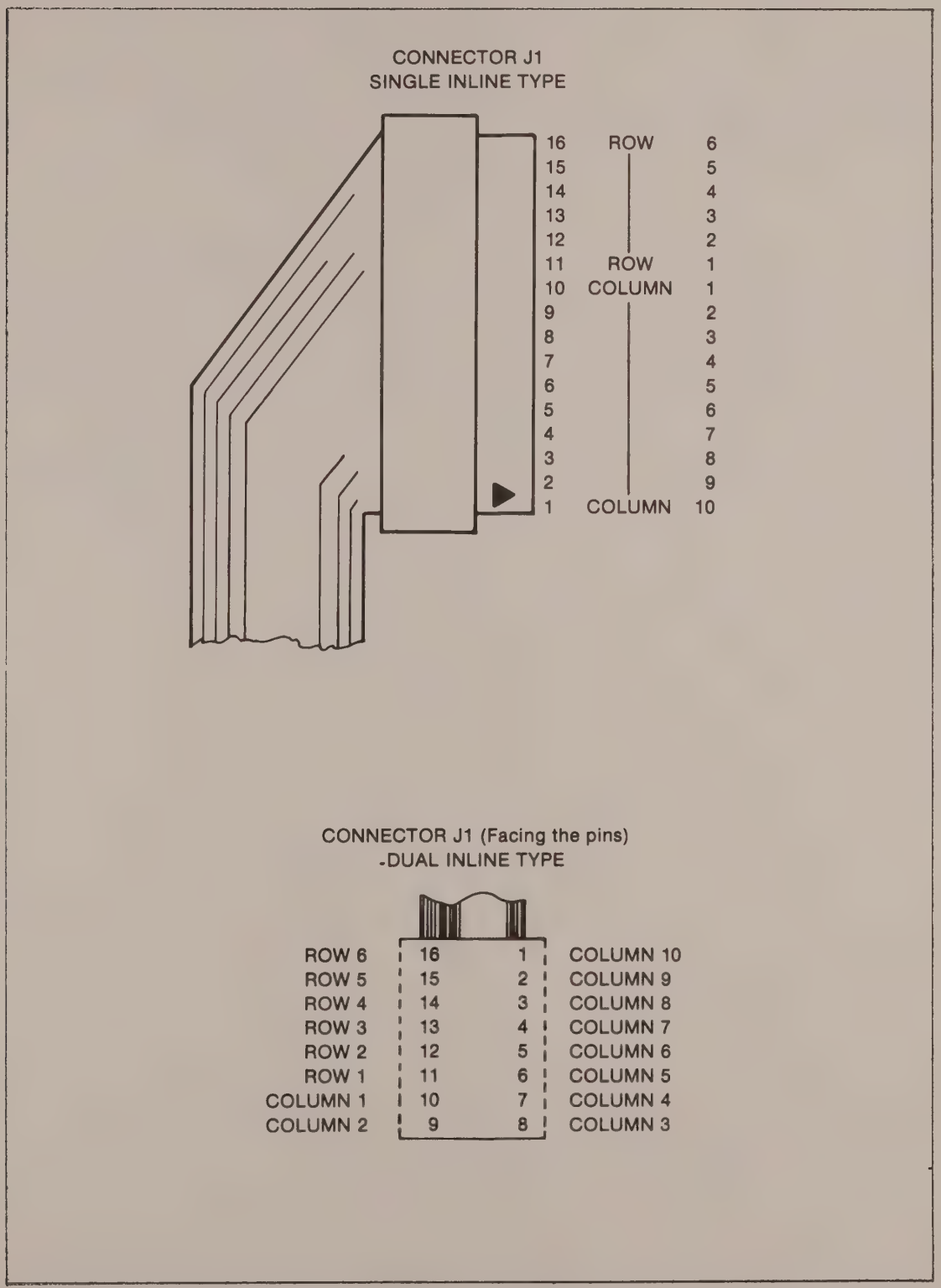

Figure 6-3. Touch-Sensitive Overlay Connector Pins

Section 7
List of Replaceable Parts

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ASSEMBLY NAME	DRAWING NO.	PAGE
Final Assembly	(1780A T&B)	7-4
A1 Main PCB Assembly	(1780A-7612)	7-4
A2 Digital Electronics Assembly		7-4
Field Service Kits		7-4

INTRODUCTION

This section contains a parts breakdown of the 1780A InfoTouch Display. Components are listed alphanumerically by assembly.

Parts lists include the following information:

1. Reference Designation.

2. Description of each part.

3. FLUKE Stock Number.

4. Federal Supply Code for Manufacturers. (See the list at the end of the manual.)

5. Manufacturer's Part Number.

6. Total quantity of components per assembly.

7. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five InfoTouch Displays for a period of 2 years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for 1 year or more at an isolated site, it is recommended that at least one of each assembly in the 1780A be stocked (see the next to the last paragraph on the next page). In the case of optional subassemblies, plug-ins, etc., that are not always part of the 1780A, or that are deviations from the basic model, the REC QTY column lists the recommended spares quantity for the items in that particular assembly.

HOW TO OBTAIN PARTS

Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. or its authorized representative by using the FLUKE STOCK NUMBER.

NOTE

Module assemblies must be ordered with the FLUKE STOCK NUMBER. Do not use the manufacturer's part number to order these assemblies.

In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

To ensure prompt and efficient handling of your order, include the following information:

1. Quantity.

2. FLUKE Stock Number.

3. Description.

4. Reference Designation.

5. Printed Circuit Board Part Number and Revision Letter.

6. Instrument Model and Serial Number.

A Recommended Spare Parts Kit for your basic 1780A is available from the factory. This kit contains those items listed in the REC QTY column of the parts list in the quantities recommended.

Parts price information is available from the John Fluke Mfg. Co., Inc. or its representative. Prices are also available in a Fluke Replacements Parts Catalog, which is available on request.

CAUTION

*

Indicated devices are subject to damage by static discharge.

Table 7-1. 1780A List of Replaceable Parts

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
MP1	CORD SET	284174	89536	284174	1		
MP2	DECAL, CORNER	634238	89536	634238	4		
MP3	DECAL, IMPLOSION PROTECTION	577387	89536	577387	2		
MP4	DECAL, TITLE	634246	89536	634246	1		
MP5	DECAL, TRIM	634394	89536	634394	2		
MP6	FOOT	527473	89536	527473	4		
MP7	BAIL	523571	89536	523571	1		
MP8	1780A INSTRUCTION MANUAL	630798	89536	630798	1		
MP9	PAD, PROGRAMMING WORKSHEET	533547	89536	533547	1		
A1	MAIN PCB ASSEMBLY (1780A-7612)	805168	89536	805168	1	1	2
U20	IC, DIGITAL, RAM	584144	89536	584144	1	1	2
U27	IC, DIGITAL, EPROM	632893	89536	632893	1	1	2
U28	IC, DIGITAL, MICROPROCESSOR	504332	01295	TMS9981N	1	1	2
U32	IC, DIGITAL, EPROM	630806	89536	630806	1	1	2
U33	IC, DIGITAL, CRT CONTROLLER	605741	34649	P8276	1	1	2
U35	UART	483552	01295	TMS9902NL	1	1	2
Y1	OSCILLATOR, 12.77 MHz	529610	04713	K1115A	1	1	2
F1	FUSE, 1A 250V, FAST-BLO	369819	71400	AGC1	1	1	
MP1	AIR FILTER	605899	89536	605899	1		
A2	DIGITAL ELECTRONICS ASSEMBLY	See CRT Kit					
FIELD SERVICE KITS							
#1	CRT KIT (CRT AND ELECTRONICS ASSEMBLY)	718056	89536	718056	AR	1	1
#2	1780A MAINTENANCE KIT	537472	89536	537472	AR	1	1
	A1 MAIN PCB ASSEMBLY	805168	89536	805168	1	1	
	TOUCH-SENSITIVE OVERLAY	546556	89536	546566	1	1	
	TOUCH-SENSITIVE OVERLAY EXTENDER CABLE	448548	89356	448548	1	1	
	ALIGNMENT TOOL	572321	72653	9302	1	1	
	PLASTIC SCREWDRIVER	153049	56289	GTT-5	1	1	
	FAN	631929	82877	SU2C1	1	1	
	FUSES, 1A 250V, FAST-BLO	369819	71400	AGC1	5	5	
	FUSES, 1/2A 230V, FAST-BLO	153858	71400	AGC1-2	5	5	

NOTES:

1 AR = customer option

2 Static Sensitive devices

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OPTION/ MODEL NO.	DESCRIPTION	PAGE
Y1703	RS-232-C NULL MODEM CABLE	800-1
Y1705	RS-232 NULL-MODEM CABLE	800-1
Y1707	RS-232 EXTENDER CABLES	800-1
Y1708	RS-232 EXTENDER CABLES	800-1
Y1720	PROGRAMMER KEYBOARD	800-3
Y1791	RACK MOUNT ADAPTER FOR THE 1780A	800-4
Y1792	RACK MOUNT ADAPTER FOR THE 1780A WITH KEYBOARD CONNECTOR EXTENSION	800-4
Y1793	CARRY HANDLE	800-5
M00-260-610	18-INCH RACK SLIDE KIT	800-5
M00-280-610	24-INCH RACK SLIDE KIT	800-5
1780A-001	KEYBOARD INTERFACE	001-1
1780A-002	KEYBOARD INTERFACE WITH Y1720 PROGRAMMER KEYBOARD	002-1
1780A-201	EXTENDED GRAPHICS CHARACTER SET	201-1

INTRODUCTION

This section of the manual contains information concerning the options and accessories available for use with the Model 1780A InfoTouch Display. It consists of an introductory section and a series of option subsections. All options and accessories are listed by model number or option number in the Table of Contents.

ACCESSORIES

The accessories are briefly described in the Accessories subsection. Complete information about the accessories is provided, where necessary, in stand-alone manuals shipped with each accessory.

OPTIONS

Each option is documented in an individual subsection of this manual section. Each option subsection includes all information for that option. The page numbers correspond to the option number so that it is easy to find a particular subsection. For example, page 001-1 is the first page of information about Option -001.

Subsections for options available at the time of this printing are included in this manual. Contact your nearest Fluke sales representative for a current list of available options.

INTRODUCTION

The following paragraphs briefly describe accessories available for use with the 1780A. For more information, refer to the instruction sheet included with each accessory. When ordering accessories, please include both model number and name.

RS-232-C NULL MODEM CABLES (Y1703 and Y1705)

The Y1703 and Y1705 Null Modem Cables are standard RS-232-C interface cables with female pins on each end. The necessary lines in the Y1703 and the Y1705 are crossed to change the 1780A standard terminal-type interface into a standard modem-type interface. The Y1703 and Y1705 are used to connect the 1780A to a standard terminal type interface such as the John Fluke 1720A. The Y1703 is 4 meters long. The Y1705 is 0.3 meters long. Figure 800-1 is a schematic of the Y1703 and Y1705.

RS-232-C EXTENDER CABLES (Y1707 and Y1708)

The Y1707 and Y1708 extend the RS-232-C interface on the 1780A without changing its function. The male connector on one end of these cables is connected, pin for pin, to the female connector on the other end. The Y1707 is 2 meters long. The Y1708 is 10 meters long. Figure 800-2 is a schematic of the Y1707 and Y1708.

FEMALE CONNECTOR

FEMALE CONNECTOR

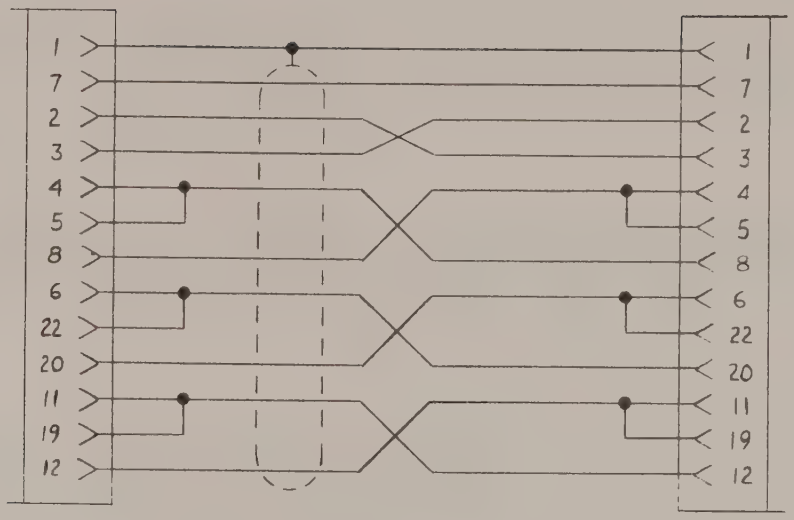


Figure 800-1. Y1703 and Y1705 RS-232-C Accessory Cable Wiring Diagram

FEMALE CONNECTOR

MALE CONNECTOR

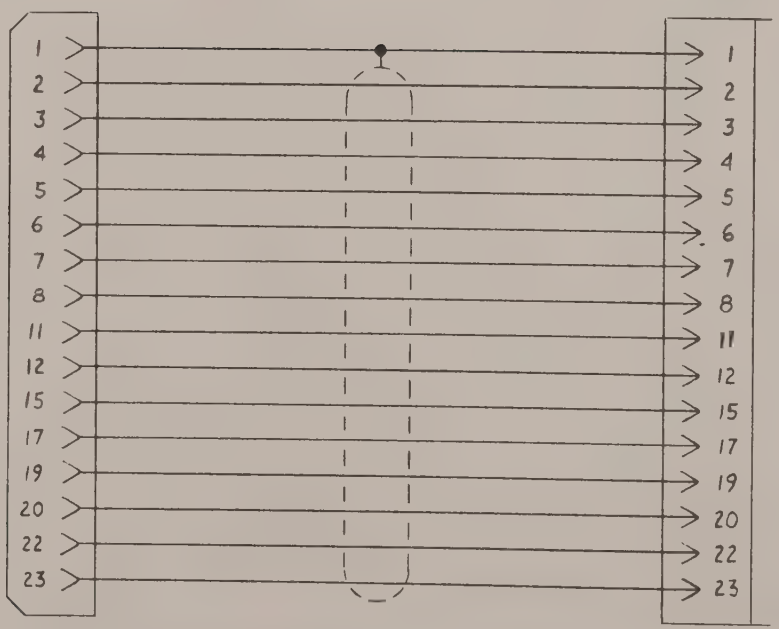


Figure 800-2. Y1707 and Y1708 RS-232-C Accessory Cable Wiring Diagram

PROGRAMMER KEYBOARD (Y1720)

Introduction

The Y1720 is a full ASCII keyboard with a special six key pad. When a Y1720 is connected through a 1780A-001 Keyboard Interface, the 1780A functions as a standard ASCII terminal. Figure 800-3 shows the Y1720A Programmer Keyboard. Table 800-1 lists the codes generated by the 1780A when the CTRL and SHIFT keys are held down simultaneously.

ANSI Control Sequences

There are two ANSI control sequences that are used with the Y1720 Programmer Keyboard only: Break Function and Local/Remote.

BREAK FUNCTION -- <CTRL>/<ESC> <B>

The Break Function sequence sets the data transmission line to zero for about one half of one second. Do the following:

1. While pressing the <CTRL> key, press <ESC>.

2. Press <B>.

LOCAL/REMOTE -- <CTRL> <ESC> <L> or <R>

In Local, the Y1720 inputs are interpreted as coming from the RS-232-C port and are not transmitted. In Remote, inputs from the Y1720 are recognized as originating from the 1780A-001 Keyboard Interface and are transmitted on the RS-232-C bus.

- To enter the Local mode, perform the following:

  1. While pressing <CTRL>, press <ESC>.

  2. Press <L>.

- To enter the Remote (default) mode, perform the following:

  1. While pressing <CTRL>, press <ESC>.

  2. Press <R>.

Table 800-1. CTRL/SHIFT Codes Generated By The Y1720

KEY	TOUCH-SENSE REPORT NO.	KEY	TOUCH-SENSE REPORT NO.	KEY	TOUCH-SENSE REPORT NO.
1	068	L	103	{	106
2	075	M	086	}	113
3	076	N	085	-	108
4	083		098	+	115
5	084	P	105	~	116
6	091	Q	066	ESC	067
7	092	R	081	TAB	065
8	099	S	072	CAPS LOCK	064
9	100	T	082	NEXT PAGE	061
0	107	U	090	PAGE MODE	102
A	071	V	077	LINE FEED	118
B	078	W	073	RETURN	119
C	070	X	069	DELETE	114
D	079	Y	089	BACK SPACE	123
E	074	Z	062	(space)	109
F	080	<	093		124
G	087	>	094		122
H	088	?	101		NA
I	097	:	104		NA
J	095	"	111	DEL LINE	128
K	096	\	112	DEL CHAR	126

RACK MOUNT ADAPTER FOR THE 1780A (Y1791)

The Y1791 (Figure 800-4) allows the 1780A to be mounted on either the right or the left side of a standard 19-inch equipment rack. The appropriate rack slide kit accessory (M00-260-610 or M00-280-610) must also be used.

RACK MOUNT ADAPTER FOR THE 1780A WITH KEYBOARD CONNECTOR (Y1792)

The Y1791 (Figure 800-5) allows the 1780A to be mounted on either the right or the left side of a standard 19-inch equipment rack. The appropriate rack slide kit accessory (M00-260-610 or M00-280-610) must also be used. The Y1792 includes an extension cable and a panel mounted connector to bring the optional 1780A-001 Keyboard Interface forward to a front filler panel.

CARRY HANDLE (Y1793)

A 1780A with the Y1793 Carry Handle installed can be easily transported with greater safety. The carry handle is installed in the place of one of the side inserts.

18-INCH RACK SLIDE KIT (M00-260-610)

The M00-260-610 Rack Slide Kit allows the 1780A to be installed in a standard 18-inch deep equipment rack when used with the Y1791 or Y1792 rack mount adapter. The rack slide kit is shown in Figure 800-6.

24-INCH RACK SLIDE KIT (M00-280-610)

The M00-280-610 Rack Slide Kit allows the 1780A to be installed in a standard 24-inch deep equipment rack when used with the Y1791 or Y1792 rack mount adapter. The rack slide kit is shown in Figure 800-6.

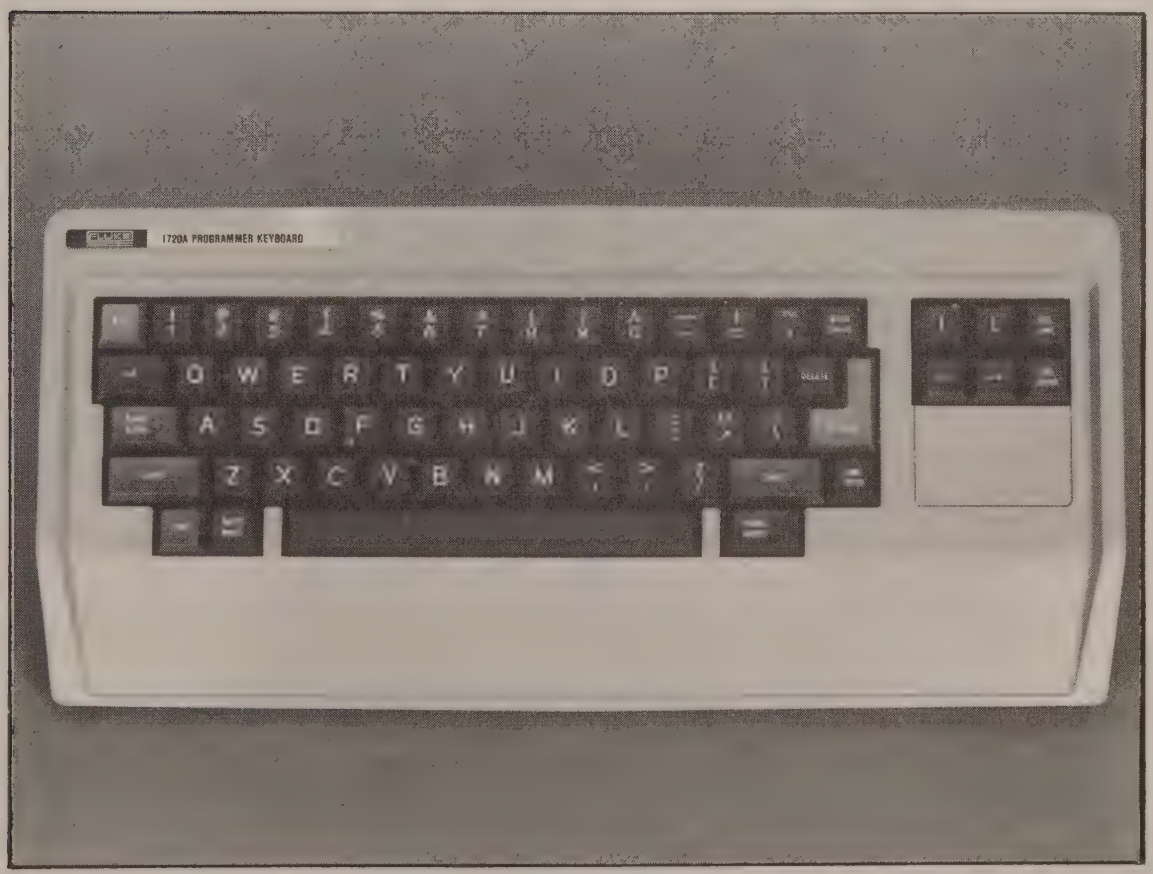


Figure 800-3. Y1720 Programmer Keyboard

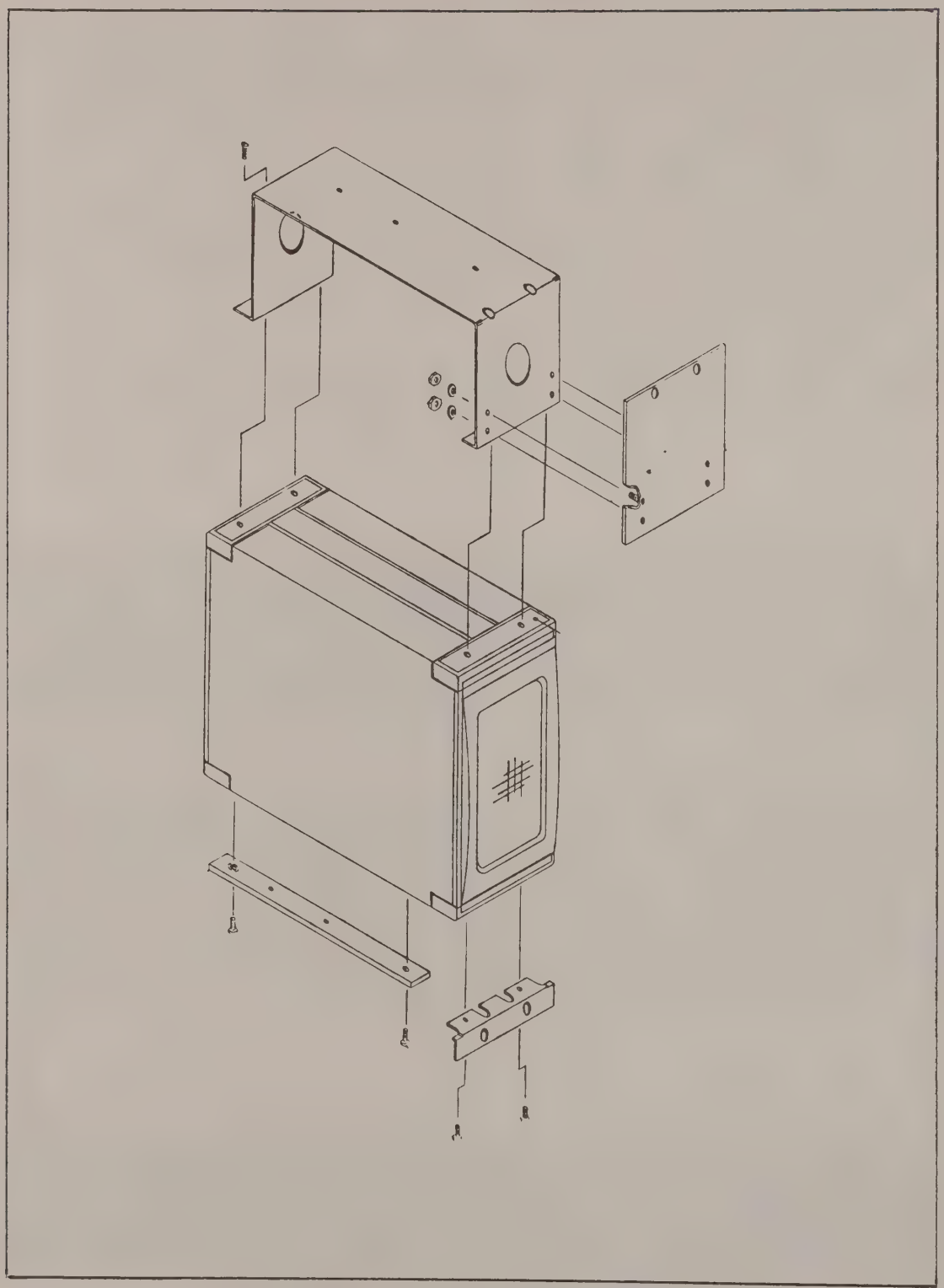


Figure 800-4. Y1791 Rack Mount Adapter

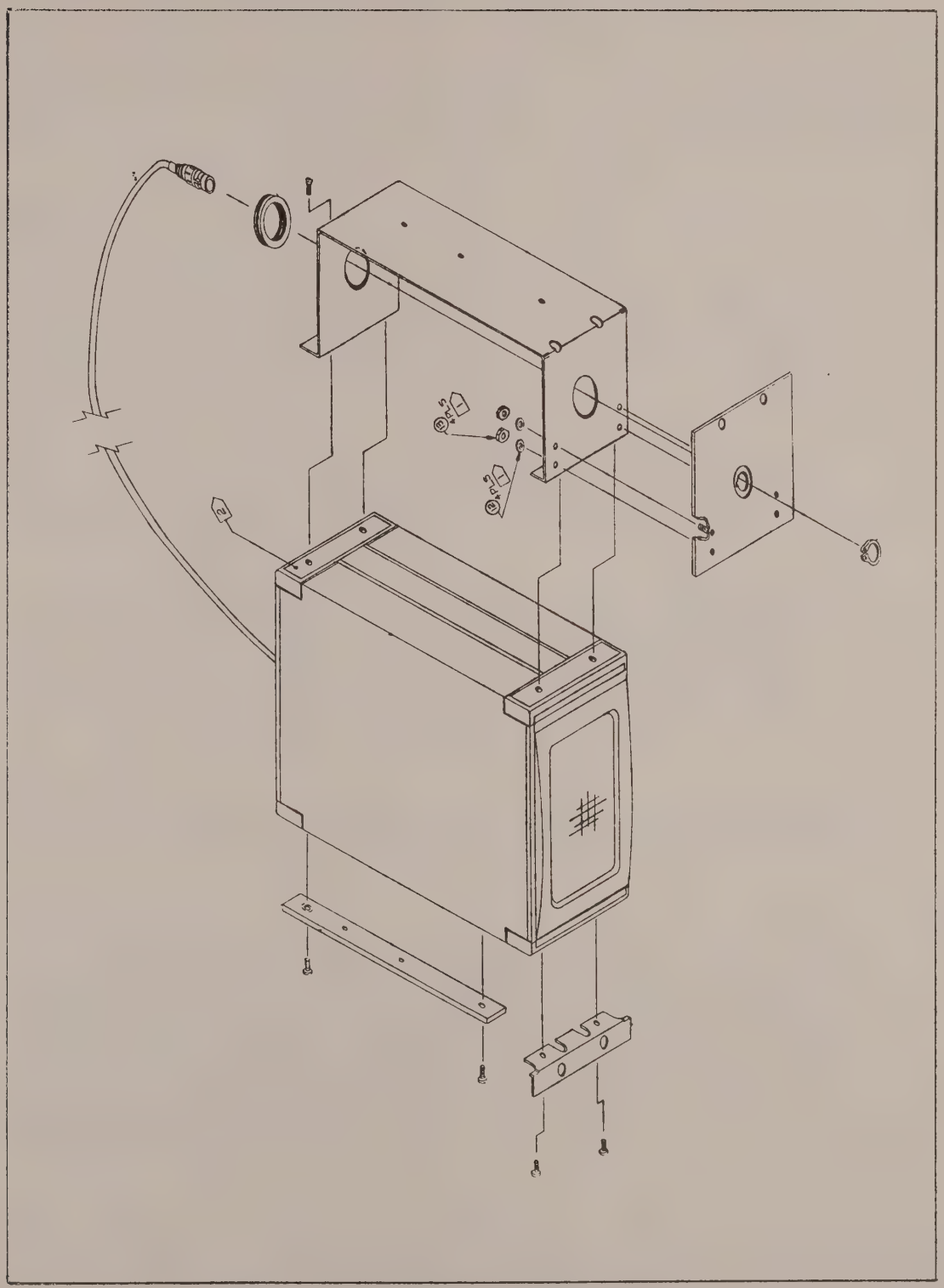


Figure 800-5. Y1792 Rack Mount Adapter

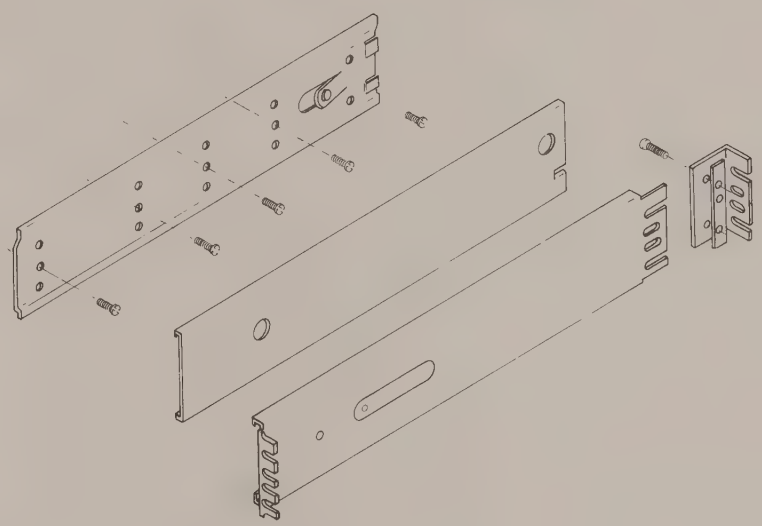


Figure 800-6. Rack Slide

Option 1780A-001
Keyboard Interfaee

INTRODUCTION

The Fluke 1780A-001 Keyboard Interface is an event-oriented parallel port suitable for use with a customized keypad, test fixture, foot switch, or available Fluke keyboard accessories. With the Y1720 Programmer Keyboard connected through this interface, the 1780A functions as a standard ASCII terminal. See Section 8 for more detailed information about the Y1720 Programmer Keyboard.

The interface provides an 8-bit parallel row-scan sense input and a 4-bit binary, 9-column-scan code output. The 9-column-scan output requires a decoder in the keyboard or test fixture. A 74LS145 is suggested for use as a column-scan decoder. The decoder can be powered from the +5V line of the 1780A-001.

The SHIFT and CTRL lines of the interface modify the ASCII code interpretation of the key inputs on the interface. Interpretation of the key inputs is described in detail later in this section as "Code Generation", but it is important to note that when both the SHIFT and the CTRL lines are used, the key inputs are interpreted as an extension of the Touch-Sense Overlay (touch-sense codes 061 through 128).

INTERFACE CONNECTOR

The 1780A-001 Keyboard Interface connector is a Viking Thorkom series connector with 24 male pins. Pin signals are defined in Table 001-1.

CODE GENERATION

The state of the SHIFT sense and CONTROL sense lines of the 1780A-001 interface modify the ASCII code interpretation of a subset of key inputs. The ASCII or Touch-Sense Format codes that are generated by an external test fixture or customized keyboard through the 1780A-001 depending upon the state of the SHIFT sense and CONTROL sense lines are listed in the Y1720 material in the Accessories subsection. Table 001-2 lists the <SHIFT>/<CTRL> codes generated by the 1720A through the 1780A-001. The test fixture or keyboard must have a column-scan decoder. We suggest using a 74LS145.

Table 001-1. 1780A-001 Keyboard Interface Pin Assignment

PIN	DESCRIPTION	I/O
1	LED, Caps Lock	Out
2	LED 2	Out
3	SHIFT Sense	In
4	LED, Page Mode	Out
5	Row-scan 7	In
6	Row-scan 4	In
7	LED 1	Out
8	LED 4	Out
9	Keyclick	Out
10	+5V, 150 ma	Out
11	Column-scan 2	Out
12	Row-scan 1	In
13	LED 5	Out
14	Row-scan 2	In
15	Row-scan 6	In
16	+5V return	Out
17	Row-scan 0	In
18	Column-scan 3	Out
19	Row-scan 3	In
20	Column-scan 1	Out
21	LED 3	Out
22	Column-scan 0	Out
23	Row-scan 5	In
24	CTRL Sense	In

1. The +5V supply is rated at 150 ma, sufficient for LEDs and a decoder IC. The 74LS145 is recommended for a decoder IC.

2. Outputs are standard TTL (74LS244).

Table 001-2. Codes Generated Through the 1780A-001 Keyboard Interface.

SENSE LINE STATUS		COLUMN								
		0	1	2	3	4	5	6	7	8
	0		120	118	110	44	47	32		
	1	122	99	98	109	46			10	
SHIFT = 0	R 2		97	100	103	106	108	39	13	
CTRL = 0	O 3		115	102	104	107	59	92		
	W 4	9	119	114	121	105	112	93		
(ASCII	5	113	101	116	117	111	91	127		
Codes)	6	27	50	52	54	56	48	61	8	
	7	49	51	53	55	57	45	96		
	0		88	86	78	60	63	32		
	1	90	67	66	77	62			10	
SHIFT = 1	R 2		65	68	71	74	76	34	13	
CTRL = 0	O 3		83	70	72	75	58	124		
	W 4	9	87	82	89	73	80	125		
(ASCII	5	81	69	84	85	79	123	127		
Codes)	6	27	64	36	38	40	94	43	8	
	7	33	35	37	42	41	95	126		
	0		24	22	14					
	1	26	3	2	13					
SHIFT = 0	R 2		1	4	7	10	11			
CTRL = 1	O 3		19	6	8	12				
	W 4		23	18	25	9	16			
(ASCII	5	17	5	20	21	17				
Codes)	6									
	7									
	0	061	069	077	085	093	101	109	117	125
	1	062	070	078	086	094	102	110	118	126
SHIFT = 1	R 2	063	071	079	087	095	103	111	119	127
CTRL = 1	O 3	064	072	080	088	096	104	112	120	128
	W 4	065	073	081	089	097	105	113	121	
(Touch-	5	066	074	082	090	098	106	114	122	
Sense	6	067	075	083	091	099	107	115	123	
Codes)	7	068	076	084	092	100	108	116	124	

The following convention is observed in this table:

SHIFT or CTRL = 0 means that the sense line(s) is open.

SHIFT or CTRL = 1 means that the sense line(s) is connected to pin 16 (+5V RETURN) of the 1780A-001 connector.

Refer to Figure 9-7 for Row and Column nomenclature.

ANSI CONTROL SEQUENCES

Introduction

The 1780A-001 requires the use of ANSI control sequences in addition to those used by the 1780A. Some of these control sequences are Fluke enhancements to those sequences defined in the ANSI standard. The 1780A ANSI control sequences are defined in Section 4A. All definitions and conventions described in Section 4A apply to the following ANSI control sequences.

Mode Selection -- <ESC> [n ; n ; n ; ..... p

The 1780A-001 allows the selection of two additional modes: Keyboard Lock Mode and Local Echo Mode. These two modes can be selected in any combination with each other and with the modes defined in Section 4A.

KEYBOARD LOCK MODE -- <ESC> [n p

The Keyboard Lock Mode prevents the 1780A from accepting any inputs over the optional 1780A-001 Keyboard Interface that are not control characters.

- Send <ESC> [5 p to enable the Keyboard Lock Mode.
- Send <ESC> [4 p to disable the Keyboard Lock Mode. This is the default mode.
- Entries from the Touch-sense Overlay.and the host computer are not affected.

LOCAL ECHO MODE -- <ESC> [N P

The local echo mode sends all inputs from the touch-sensitive overlay or from the keyboard interface to the RS-232-C interface and echos the keyboard inputs to the display.

- Send <ESC> [8 p to enable the Local Echo Mode.
- Send <ESC> [9 p to disable the Local Echo Mode. This is the default condition.
- In certain applications, this mode of operation can save time since it relieves the host computer of the echoing requirement.

Set LED Lines -- <ESC> [n ; n; n ... q

The Set LED Lines command sets LED line(s) of the optional -001 Keyboard Interface connector indicated by the value(s) of the parameter(s) n.

- These escape sequences are Fluke-defined.
- Each parameter n must be separated by a semicolon. Do not place a semicolon after the last parameter.

- The parameter n has the eleven possible values listed in Table 001-3.

- EXAMPLES:

  1. The following sequence sets LED lines 2, 3, and 5:

     <ESC> [2 ; 3 ; 5 q

  2. The following sequences clears all LED lines (default condition).

     <ESC> [0 q

Table 001-3. LED Line Parameter Values

VALUE OF n	ACTION
0	Clears all LED lines.
1	Sets LED line #1.
2	Sets LED line #2.
3	Sets LED line #3.
4	Sets LED line #4.
5	Sets LED line #5.
11	Clears LED line #1.
12	Clears LED line #2.
13	Clears LED line #3.
14	Clears LED line #4.
15	Clears LED line #5.

Y1720A ANSI Escape Sequences

There are two ANSI escape sequences that are used with the Y1720 Programmer Keyboard only: Break Function and Local/Remote. The Break Function sequence breaks the current function by setting the data transmission line to zero for about one half a second. The Local/Remote sequence allows inputs over the 1780A-001 interface to be interpreted as coming from the RS-232-C interface (Local). These escape sequences are defined in the Accessories subsection.

ANSI Escape Sequence Summary Table

Table 001-4 summarizes the ANSI Escape Sequences required for the optional Keyboard Interface and for the Y1720 Programmer Keyboard accessory. If your 1780A has this option and accessory then this table and the summary table at the end of Subsection 4A summarize the entire 1780A set of ANSI Escape Sequences.

TOUCH-SENSE REPORTING

Touch-Sense Reporting and the applicable formats are explained in detail in Section 4A. When the SHIFT and CTRL keys are held down simultaneously, keyboard entries act like an extension of the Touch-Sense Format with codes of 061 through 128 ASCII with the ASCII format selected or BC through FF, hexadecimal with the binary format selected.

Table 001-4. ANSI Standard Control Sequence Summary

NAME	SEQUENCE	DESCRIPTION
MODE SELECTION SEQUENCES		
Keyboard Lock	<ESC> [5 p	Enable Keyboard Lock Mode.
	<ESC> [4 p	Disable Keyboard Lock Mode.
Local Echo	<ESC> [8 p	Enable Local Echo Mode.
	<ESC> [9 p	Disable Local Echo Mode.
SET LED LINES: <ESC> [n ; n ; n ... q		
	<ESC> [0 q	Clears all LED lines.
	<ESC> [1 q	Sets LED line #1.
	<ESC> [2 q	Sets LED line #2.
	<ESC> [3 q	Sets LED line #3.
	<ESC> [4 q	Sets LED line #4.
	<ESC> [5 q	Sets LED line #5.
	<ESC> [1 1 q	Clears LED line #1.
	<ESC> [1 2 q	Clears LED line #2.
	<ESC> [1 3 q	Clears LED line #3.
	<ESC> [1 4 q	Clears LED line #4.
	<ESC> [1 5 q	Clears LED line #5.
NOTE The following escape sequences can only be sent from the Y1720 Programmer Keyboard.		
BREAK FUNCTION	<CTRL/ESC> <B>	Set data transmission line to zero for about 1/2 second.
LOCAL/REMOTE	<CTRL/ESC> <L>	Select Local Mode.
	<CTRL/ESC> <R>	Select Remote Mode.

Option 1780A-002

Keyboard Interface with Y1720 Programmer (ASCII) Keyboard

The optional 1780A-002 consists of one 1780A-001 Keyboard Interface and one Y1720 Programmer Keyboard accessory. With the 1780A-002 connected, the 1780A functions as a standard ASCII terminal connected to the host computer. See Section 8 of this manual for additional information.

INTRODUCTION

The optional 1780A-201 Extended Graphics Character Set is loaded in a PROM that replaces the Standard Character Set PROM. Table 201-1 lists the characters in the 1780A-201 Extended Graphics Character Set.

SELECTING THE STANDARD OR ALTERNATE CHARACTER SET

Subsection 4A describes the procedure for selecting the standard or alternate character set.

Table 201-1. 1780A-201 Extended Graphics Character Set

CODE			1780A	CODE			1780A
DECIMAL	HEXADECIMAL	OCTAL	DISPLAY	DECIMAL	HEXADECIMAL	OCTAL	DISPLAY
0	0	0	NUL*	22	16	26	
1	1	1		23	17	27	
2	2	2		24	18	30	
3	3	3		25	19	31	
4	4	4		26	1A	32	
5	5	5		27	1B	33	
6	6	6		28	1C	34	
7	7	7	BEL *	29	1D	35	
8	8	10	BS *	30	1E	36	
9	9	11	HT *	31	1F	37	
10	A	12	LF *	32	20	40	<space>
11	B	13	VT *	33	21	41	
12	C	14	FF *	34	22	42	
13	D	15	CR *	35	23	43	
14	E	16	SO *	36	24	44	
15	F	17	SI *	37	25	45	
16	10	20-		38	26	46	
17	11	21	DC1*	39	27	47	
18	12	22		40	28	50	
19	13	23		41	29	51	
20	14	24		42	2A	52	
21	15	25		43	2B	53	

* These ASCII control codes are not displayed.

Table 201-1. 1780A-201 Extended Graphics Character Set (cont)

CODE			1780A	CODE			1780A
DECIMAL	HEXADECIMAL	OCTAL	DISPLAY	DECIMAL	HEXADECIMAL	OCTAL	DISPLAY
44	2C	54		67	43	103	
45	2D	55		68	44	104	
46	2E	56		69	45	105	
47	2F	57		70	46	106	
48	30	60		71	47	107	
49	31	61		72	48	110	
50	32	62		73	49	111	
51	33	63		74	4A	112	
52	34	64		75	4B	113	
53	35	65		76	4C	114	
54	36	66		77	4D	115	
55	37	67		78	4E	116	
56	38	70		79	4F	117	
57	39	71		80	50	120	
58	3A	72		81	51	121	
59	3B	73		82	52	122	
60	3C	74		83	53	123	
61	3D	75		84	54	124	
62	3E	76		85	55	125	
63	3F	77		86	56	126	
64	40	100		87	57	127	
65	41	101		88	58	130	
66	42	102		89	59	131	

Table 201-1. 1780A-201 Extended Graphics Character Set (cont)

CODE			1780A DISPLAY	CODE			1780A DISPLAY
DECIMAL	HEXADECIMAL	OCTAL		DECIMAL	HEXADECIMAL	OCTAL	
90	5A	132		109	6D	155	
91	5B	133		110	6E	156	
92	5C	134		111	6F	157	
93	5D	135		112	70	160	
94	5E	136		113	71	161	
95	5F	137		114	72	162	
96	60	140		115	73	163	
97	61	141		116	74	164	
98	62	142		117	75	165	
99	63	143		118	76	166	
100	64	144		119	77	167	
101	65	145		120	78	170	
102	66	146		121	79	171	
103	67	147		122	7A	172	
104	68	150		123	7B	173	
105	69	151		124	7C	174	
106	6A	152		125	7D	175	
107	6B	153		126	7E	176	
108	6C	154		127	7F	177	

Section 9
Schematic Diagrams

FIGURE NUMBER	TITLE	PAGE
9-1	1780A Top and Side Views	9-2
9-2	1780A Interconnect Diagram	9-4
9-3	A1, Main PCB Assembly	9-5
9-4	1780A-001 Keyboard Interface PCB Assembly	9-18
9-5	Y1720 Programmer Keyboard	9-20

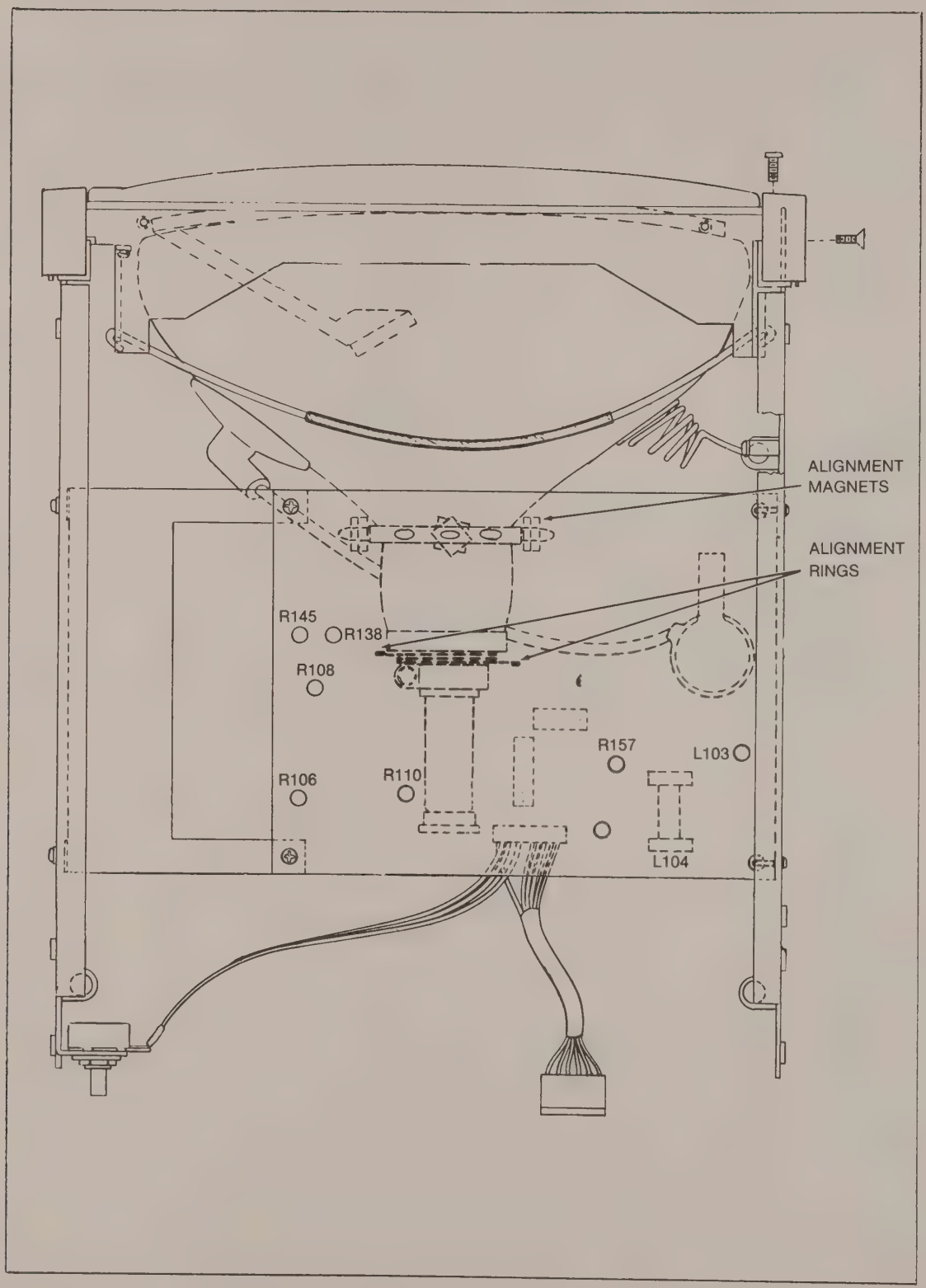


Figure 9-1. 1780A Top and Side Views

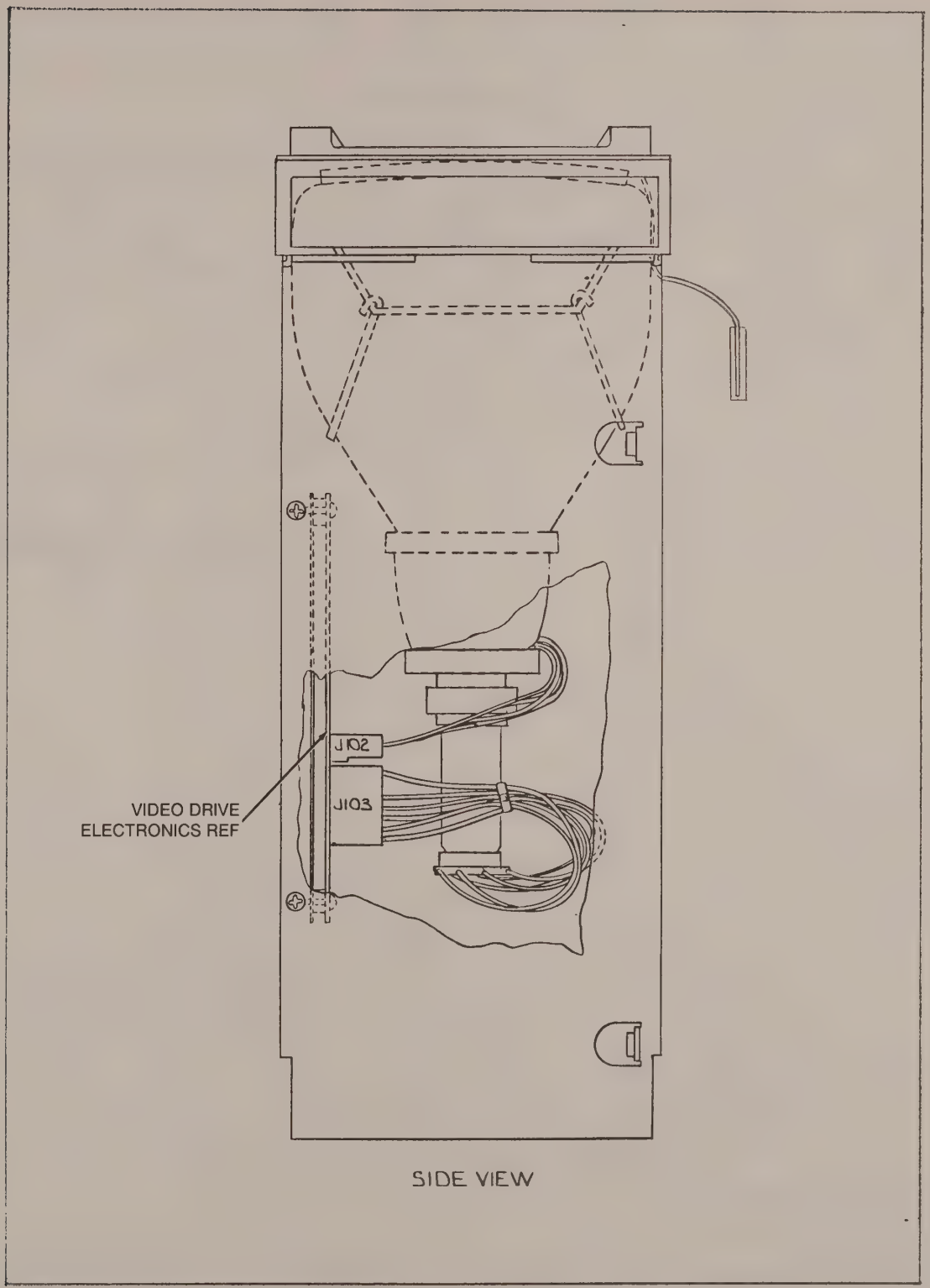


Figure 9-1. 1780A Top and Side Views (cont)

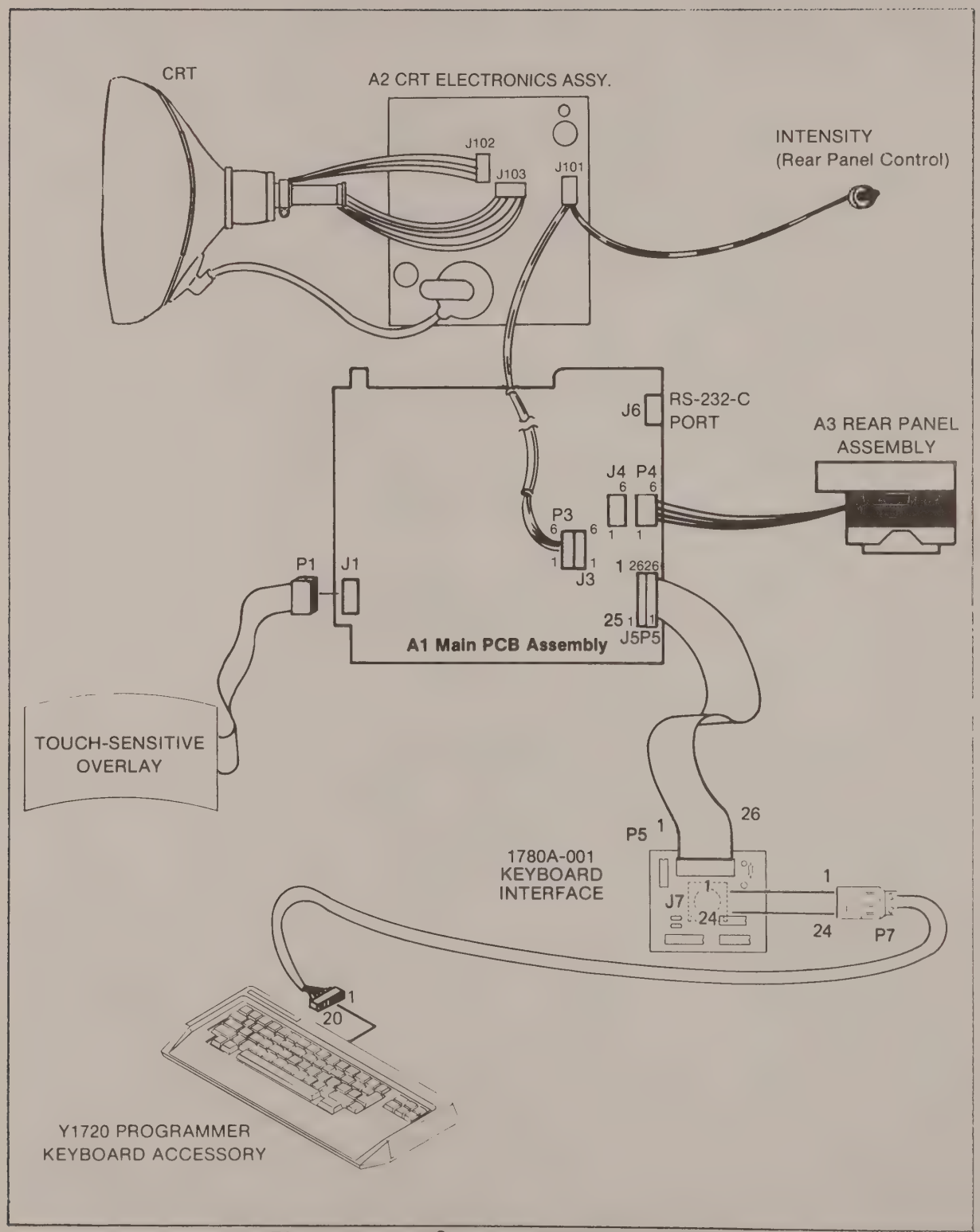


Figure 9-2. 1780A Interconnect Diagram

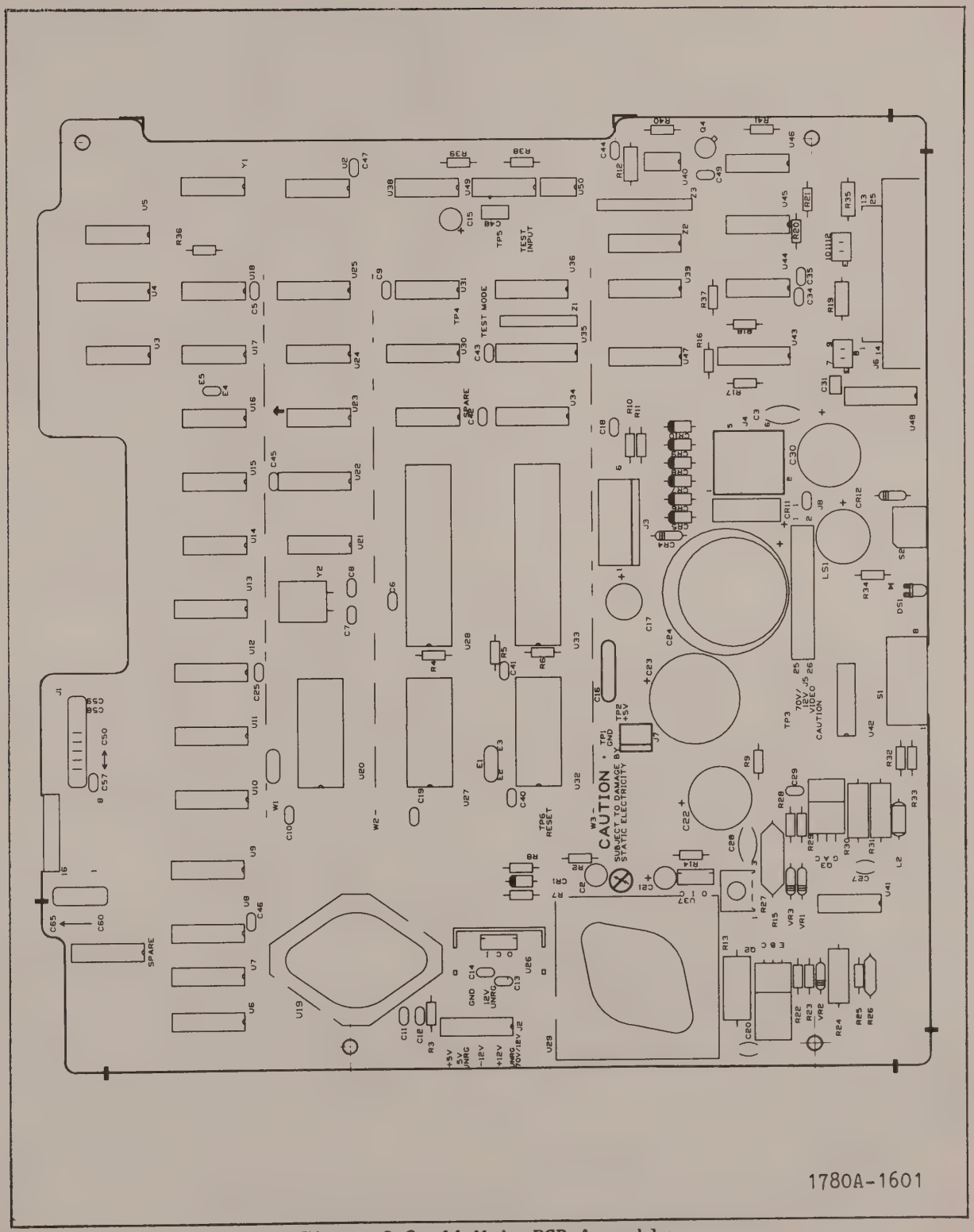


Figure 9-3. A1 Main PCB Assembly

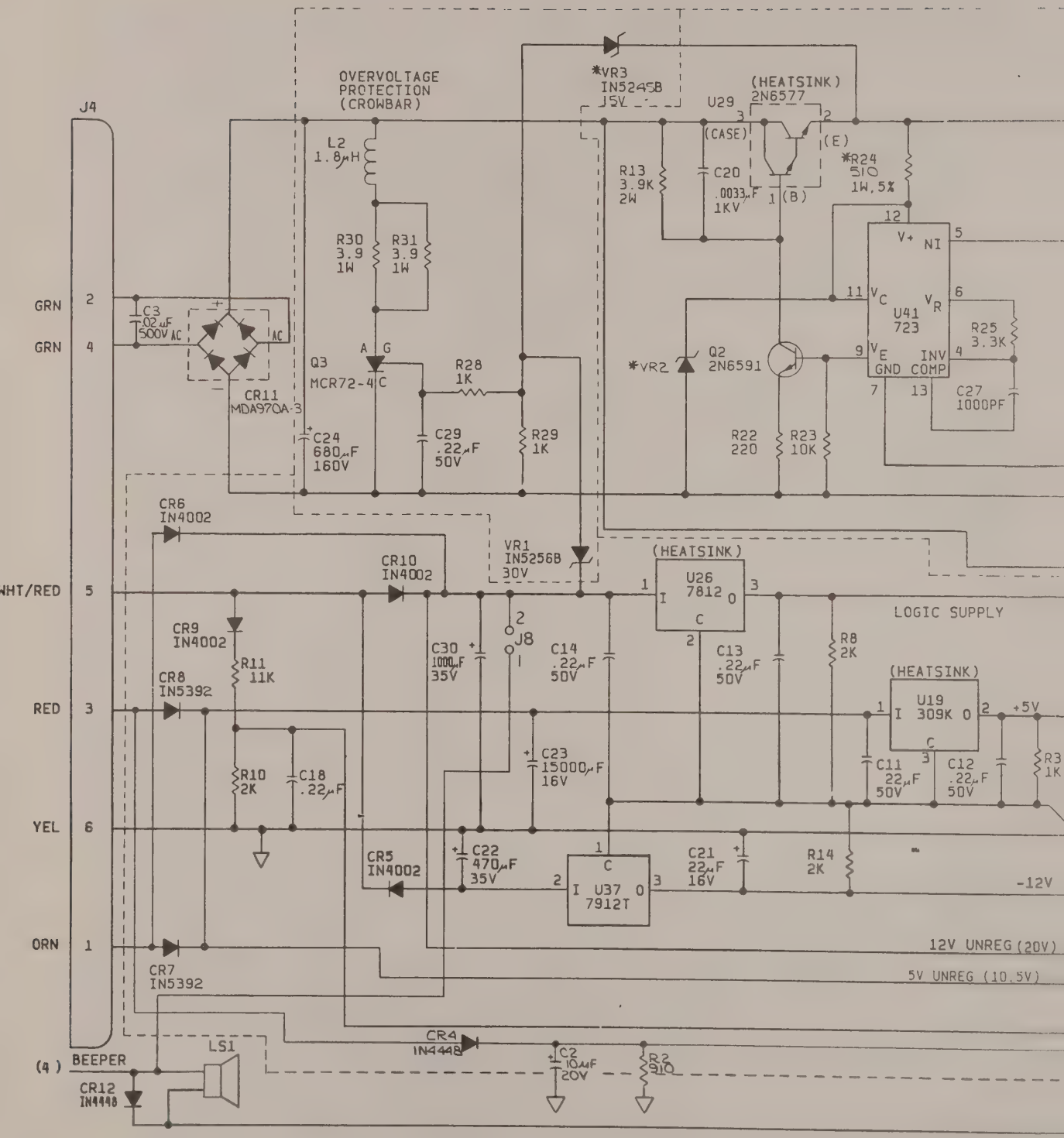
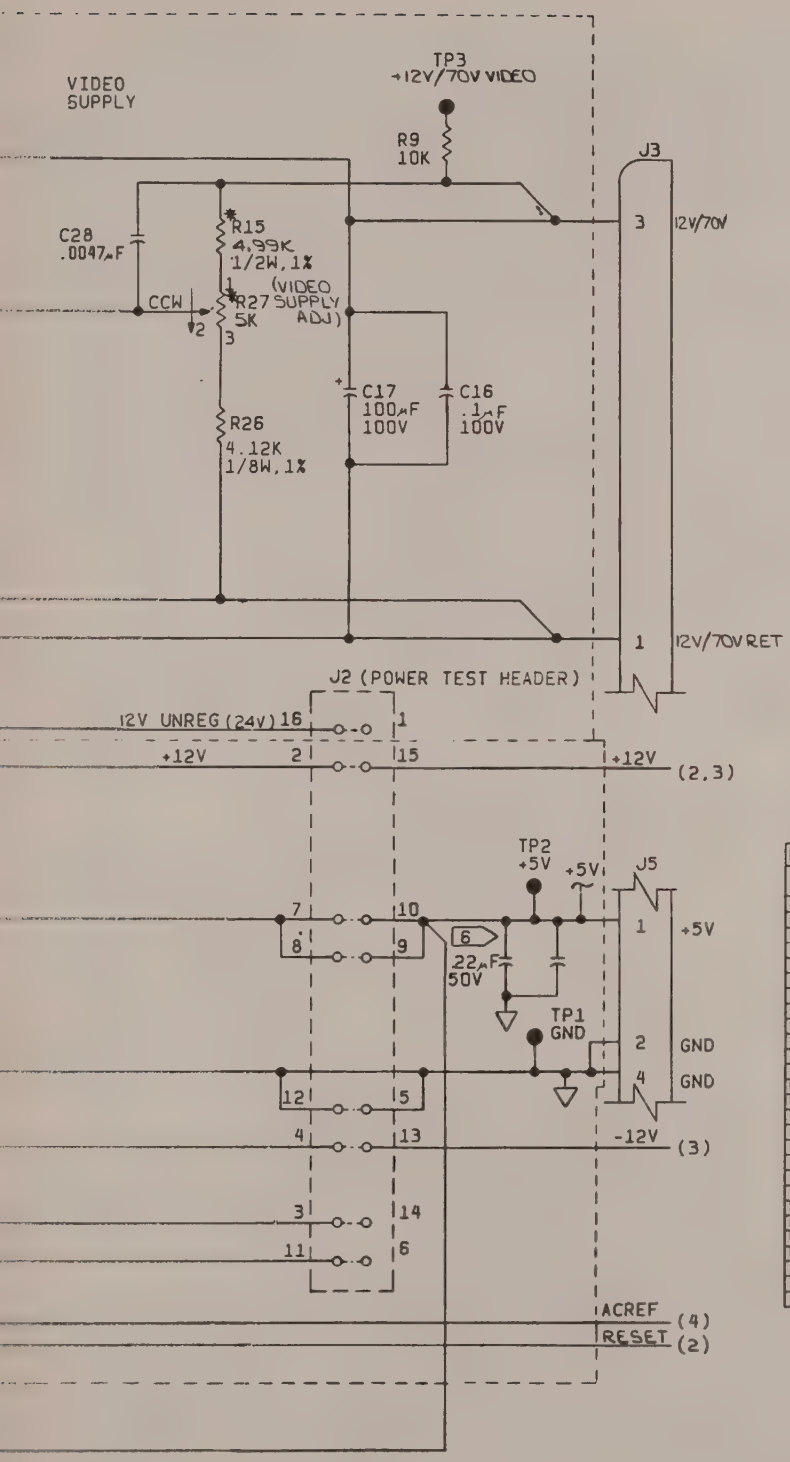


Figure 9-3. A1 Main PCB Assembly (cont)



NOTES-UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTANCE ARE IN OHMS.
2. ALL CAPACITANCES ARE IN MICROFARADS.
3. ALL RESISTORS ARE 1/4W, 5%.
4. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.14.

POWER & GND HOOKUPS		
REFERENCE DESIGNATIONS	PIN NO. +5V	GND
U2,3	14	7
U4	16	8
U5	14	7
U6-13	16	8
U14-18	14	7
U20	24	12
U21	14	7
U22	16	8
U23,24	14	7
U25	16	8
U27	24	12
U28	20	35
U30	16	8
U31	14	7
U32	24	12
U33	40	20
U34	16	8
U35	18	9
U36	16	8
U38	14	7
U39	16	8
U40	8	4
U42	16	8
U43,45,46	14	7
U44	13	7
U47	5	12

REFERENCE DESIGNATIONS	
NOT USED	LAST USED
U1,	U47
C1, 4, 26, 31-33	C65
C36-39	
CR2, 3	CR12
R1, 35	R37
Q1	Q3
	S2
	Z3
	E12
	VR3
	DS1
	LS2
	TP6
	J8

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(Sheet 1 of 6)

Figure 9-3. A1 Main PCB Assembly (cont)

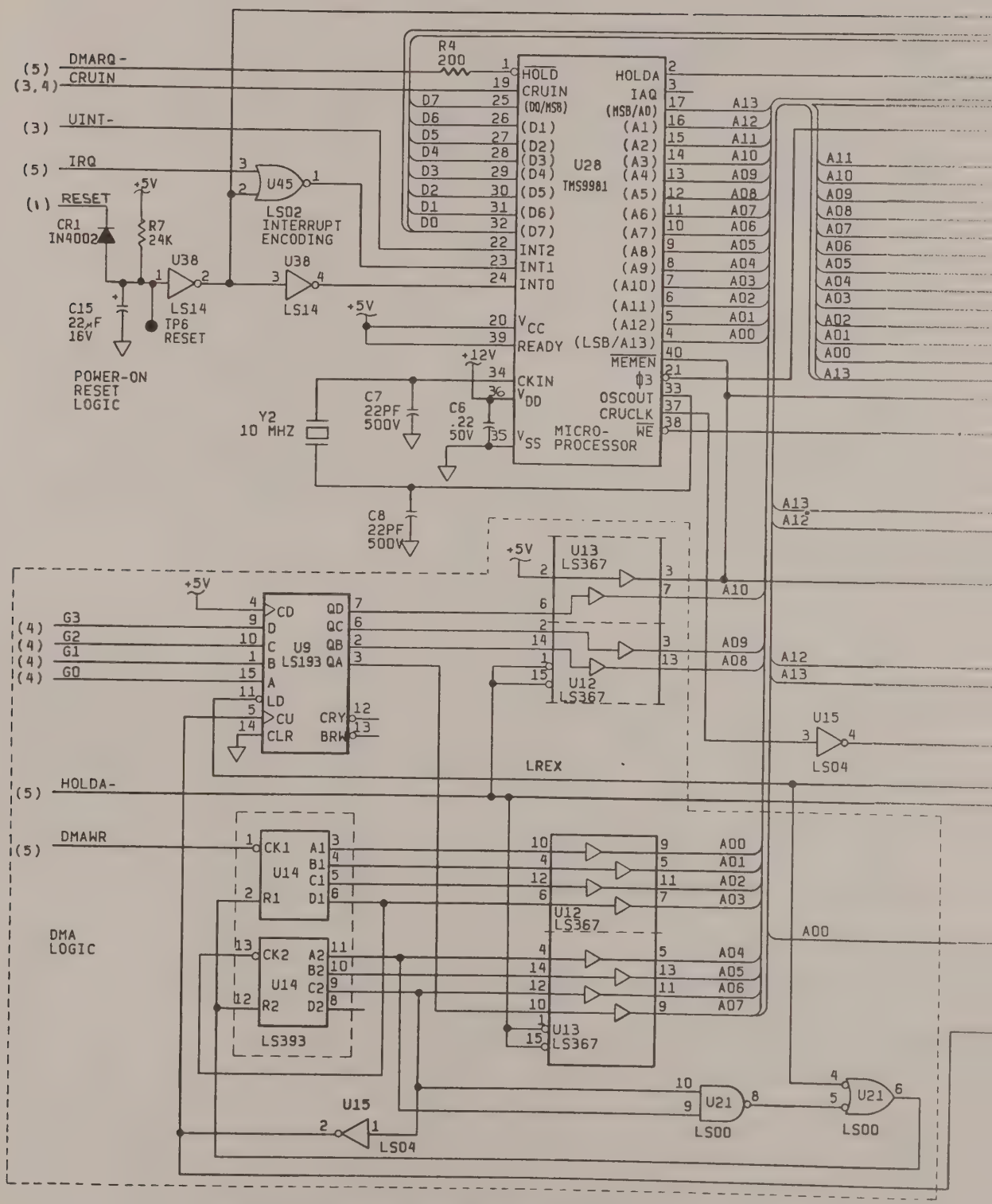
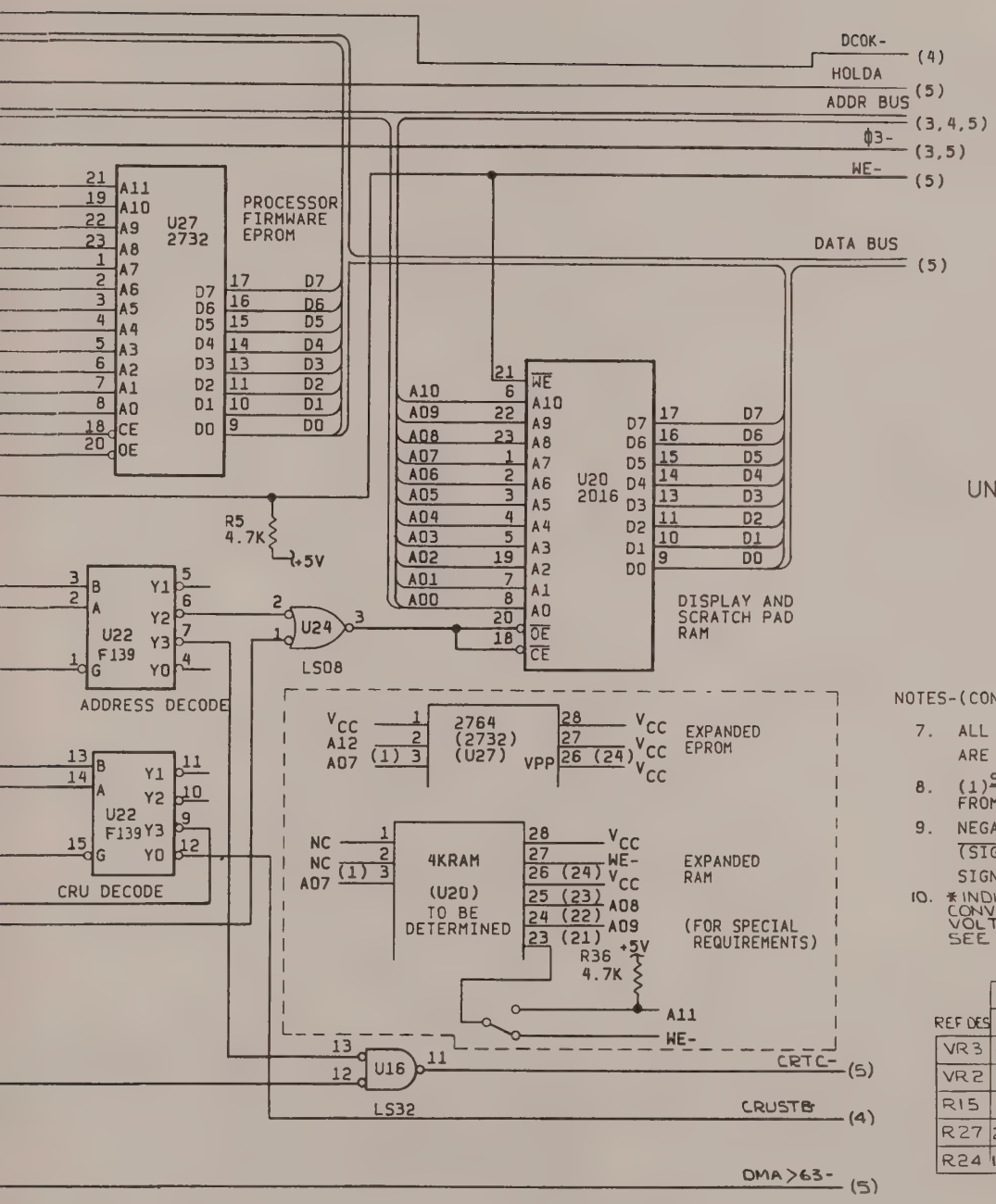
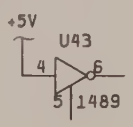


Figure 9-3. A1 Main PCB Assembly (cont)



UNUSED GATES



NOTES-(CONTINUED)

7. ALL IC'S DESIGNATED "LSXX" ARE 74LSXX SERIES.
8. (1) SIGNAL (2,3,4) FROM SHEET TO SHEET
9. NEGATIVE ASSERTION SIGNALS (SIGNAL) ARE LABELED AS SIGNAL-.
10. *INDICATES CHANGES REQUIRED TO CONVERT 1780A-4001 VIDEO SUPPLY VOLTAGES TO PRE-REV N CONFIG. SEE BELOW:

VIDEO SUPPLY VOLTAGE

	12V		70V	
REF DES	P/N	DESC	P/N	DESC
VR3	453118	15V	634139	82V
VR2	NONE		453118	15V
R15	148890	4.99K	218677	39.2K
R27	288282	5K	275750	1K
R24	157578	510	631341	6.8K

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Figure 9-3. A1 Main PCB Assembly (cont)

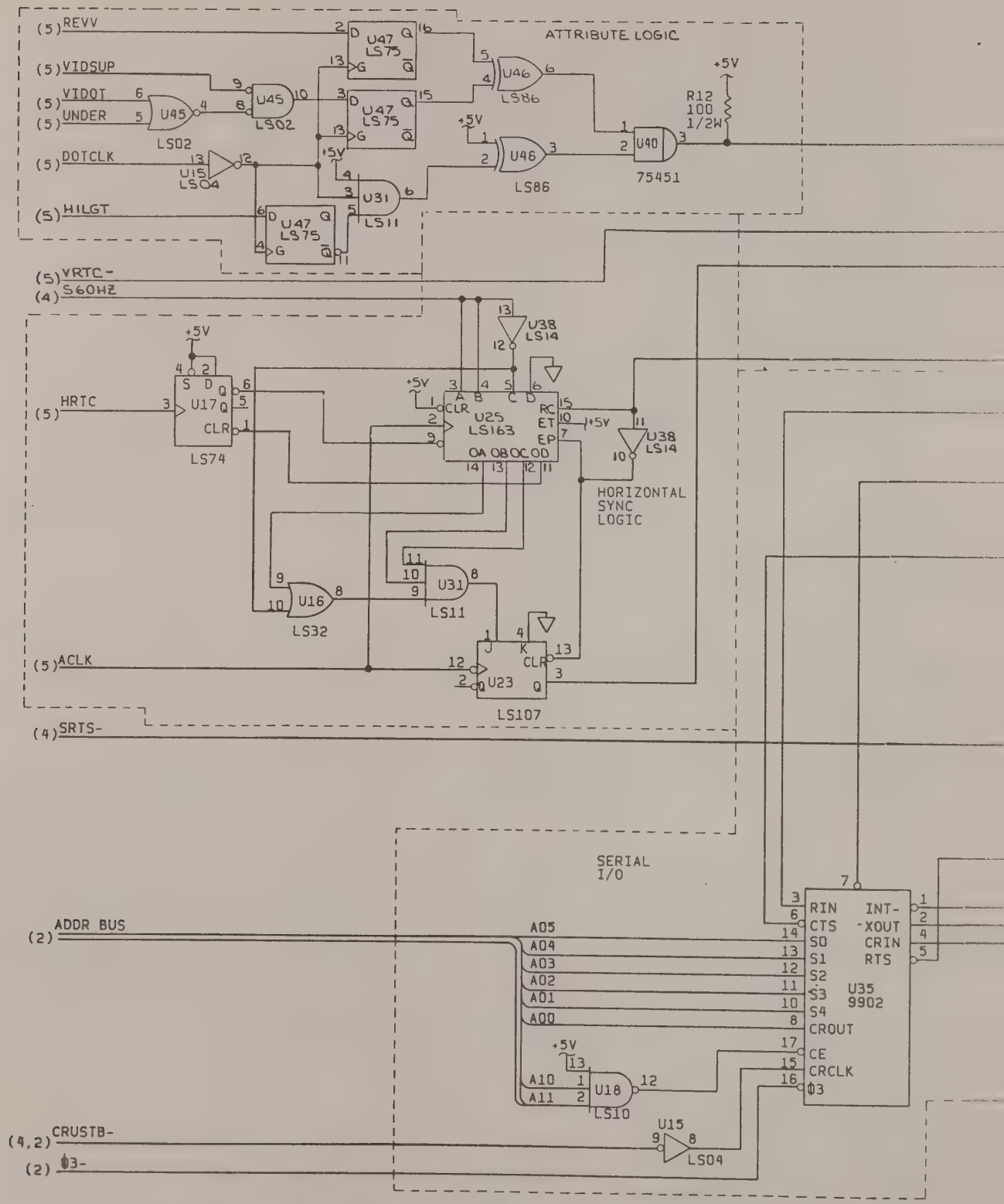
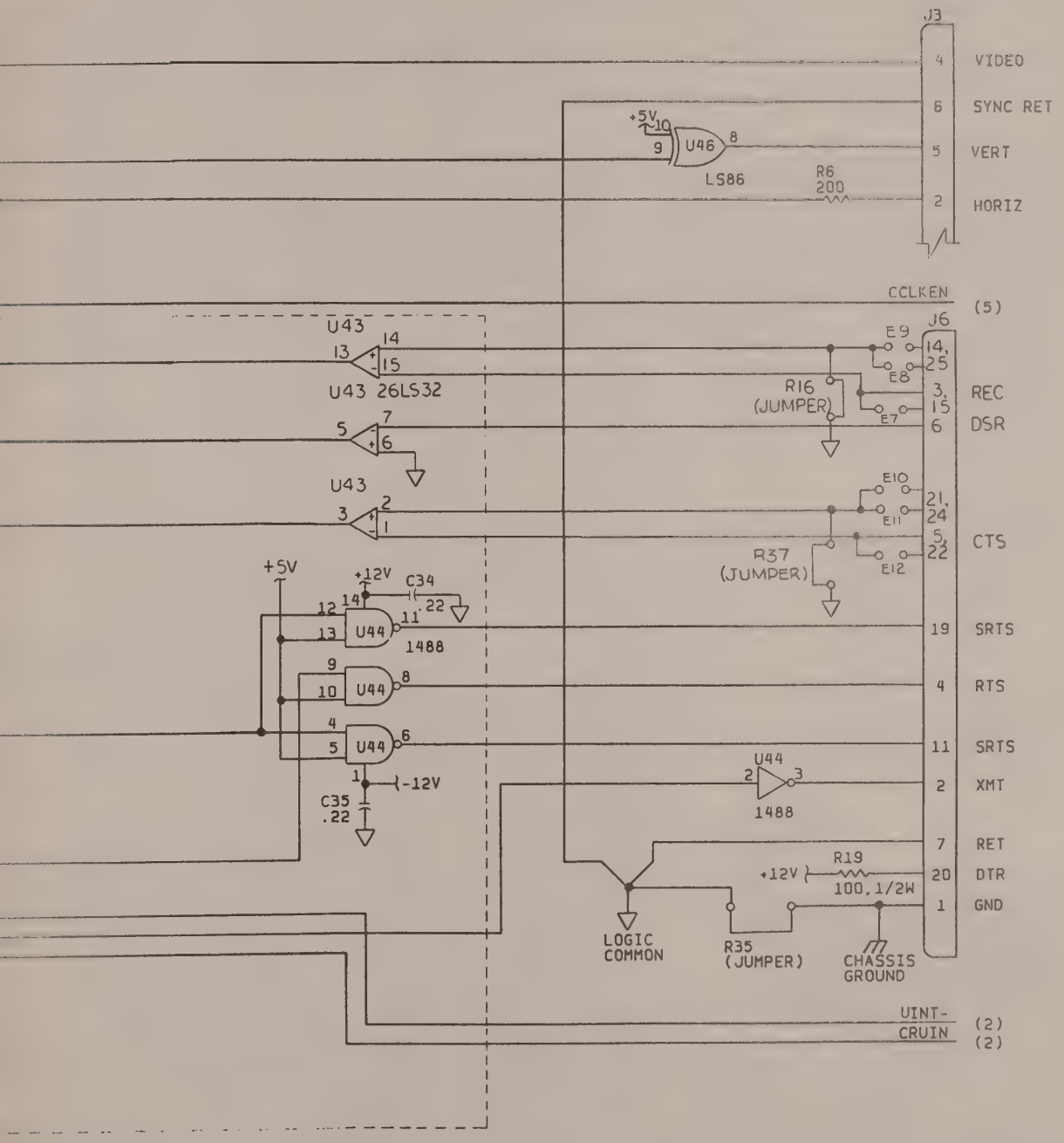


Figure 9-3. A1 Main PCB Assembly (cont)



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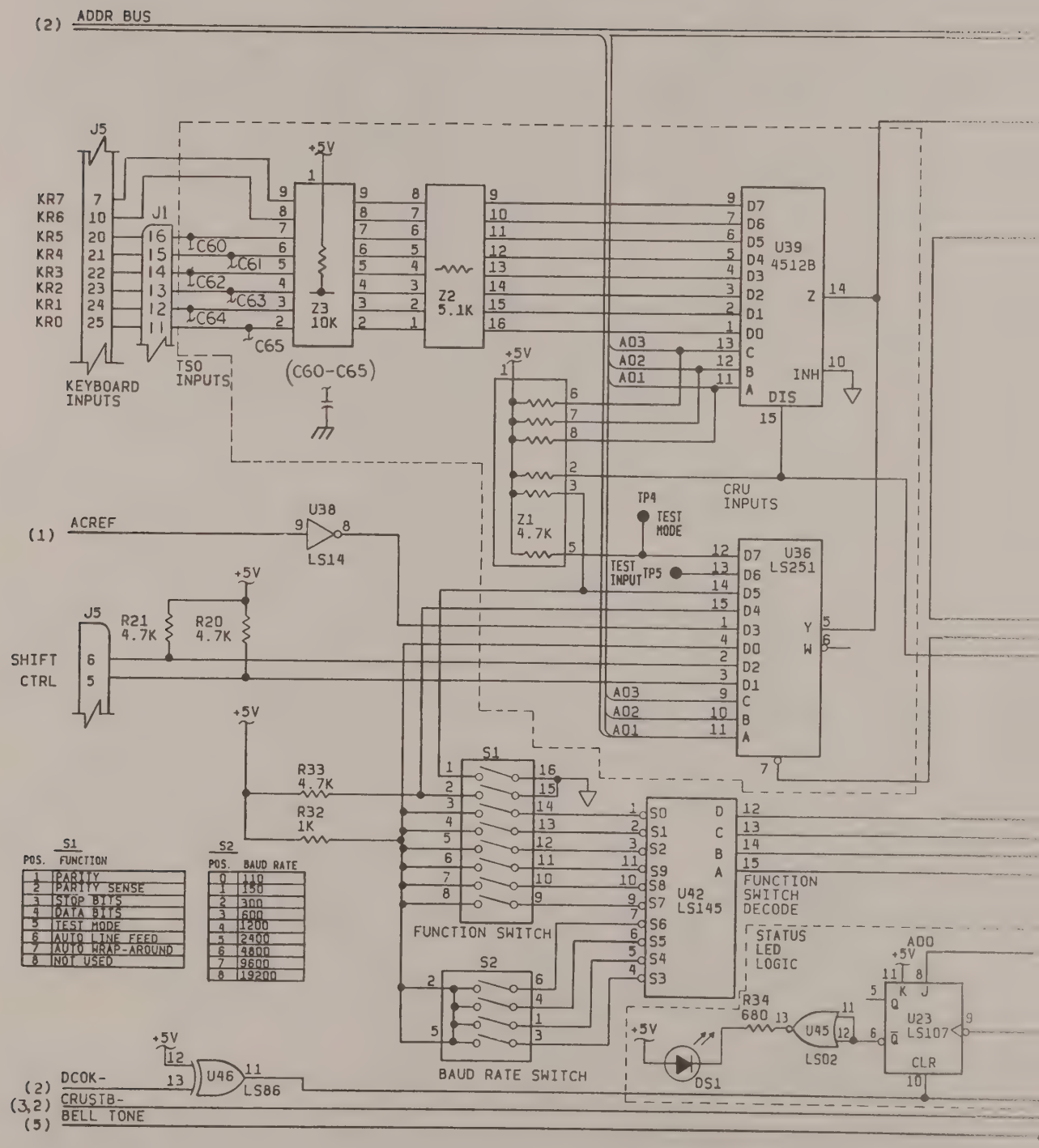
(Sheet 3 of 6)

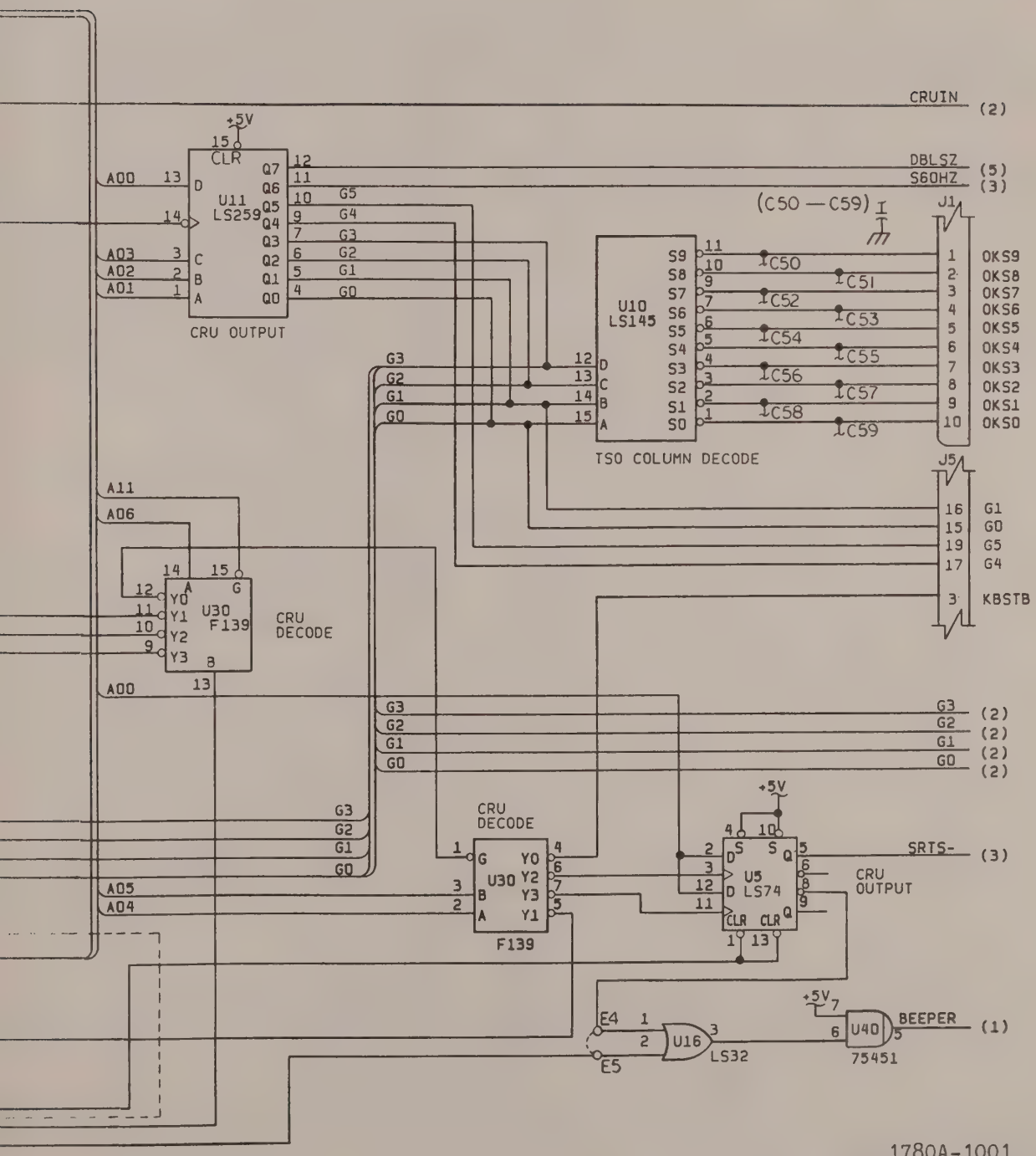
Figure 9-3. A1 Main PCB Assembly (cont)



S1	
POS.	FUNCTION
1	PARITY
2	PARITY SENSE
3	STOP BITS
4	DATA BITS
5	TEST MODE
6	AUTO LINE FEED
7	AUTO WRAP-AROUND
8	NOT USED

S2	
POS.	BAUD RATE
0	110
1	150
2	300
3	600
4	1200
5	2400
6	4800
7	9600
8	19200

Figure 9-3. A1 Main PCB Assembly (cont)



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(Sheet 4 of 6)

Figure 9-3. A1 Main PCB Assembly (cont)

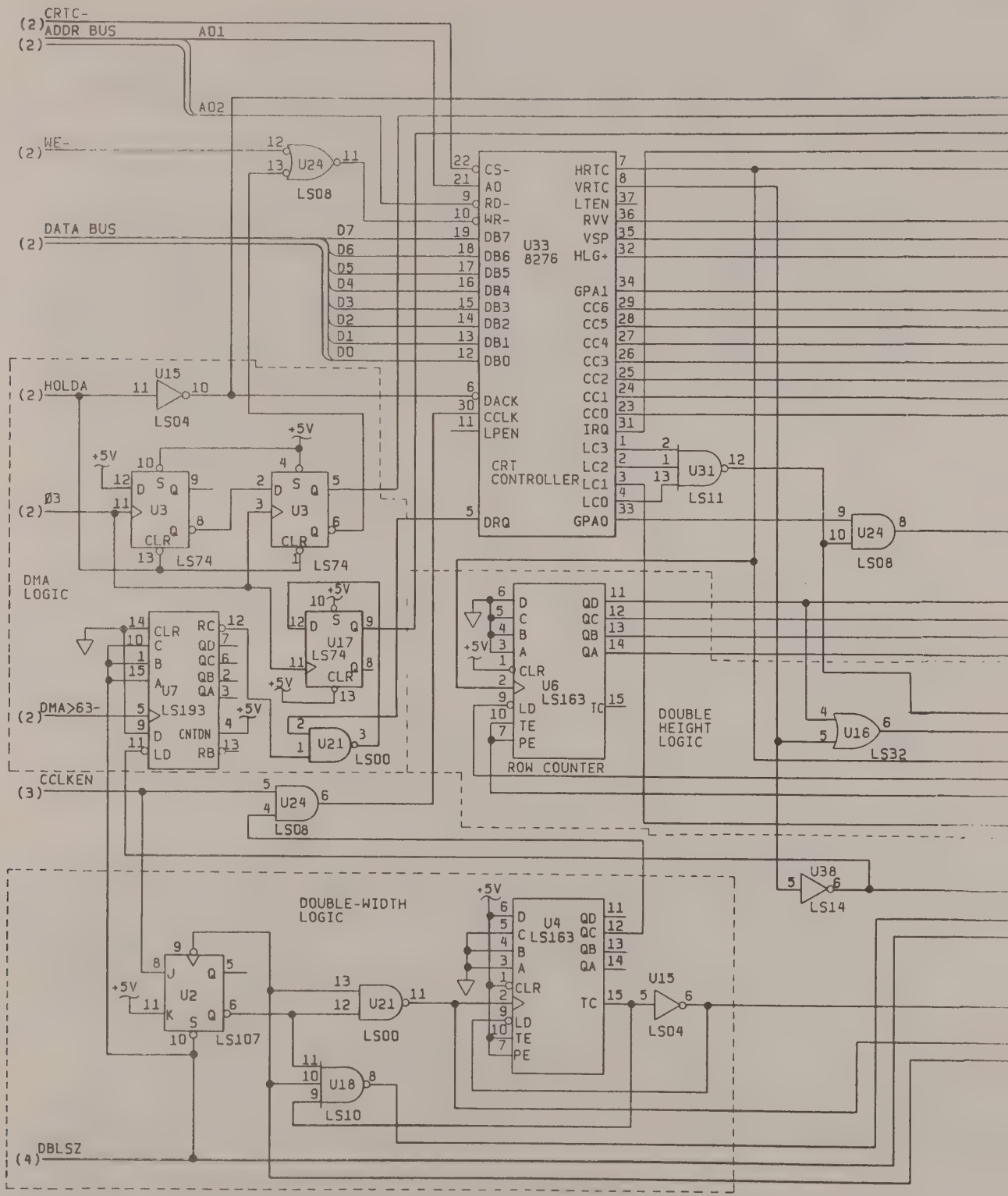
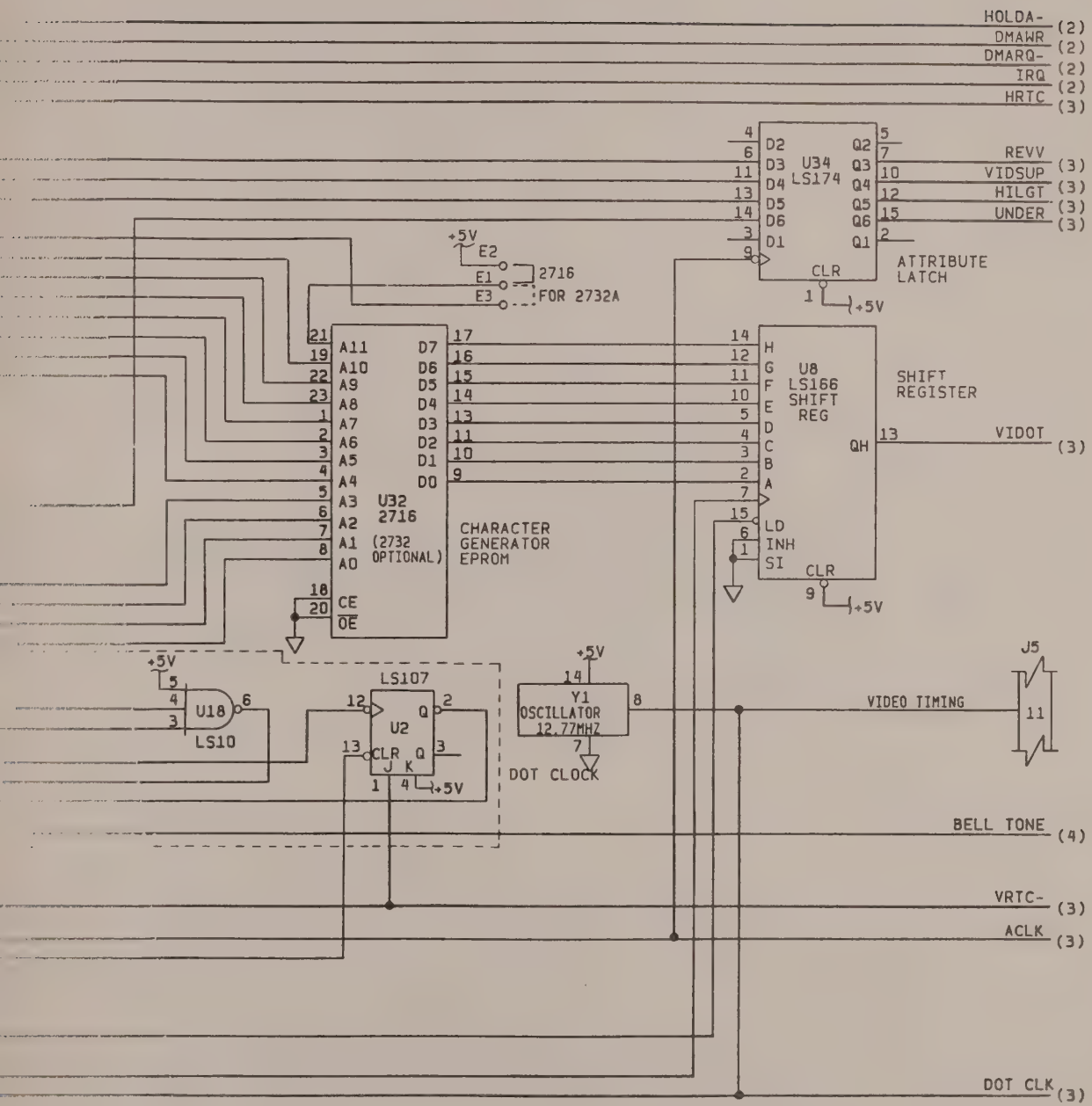


Figure 9-3. A1 Main PCB Assembly (cont)



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(Sheet 5 of 6)

Figure 9-3. A1 Main PCB Assembly (cont)

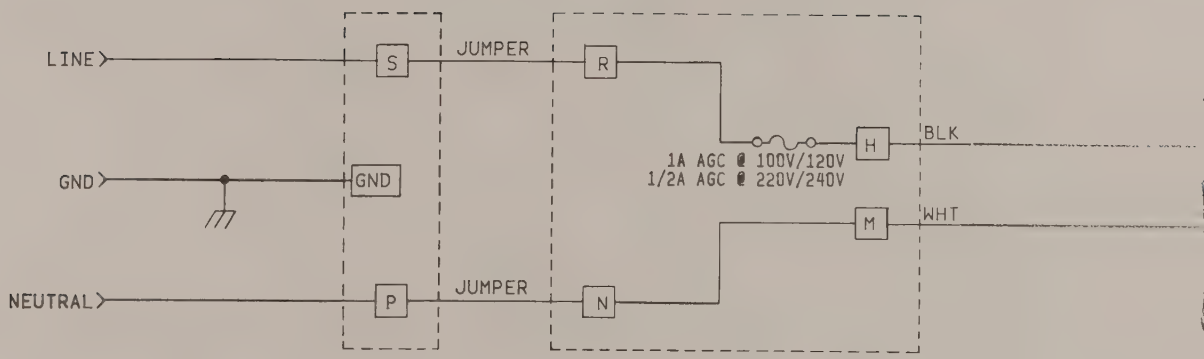
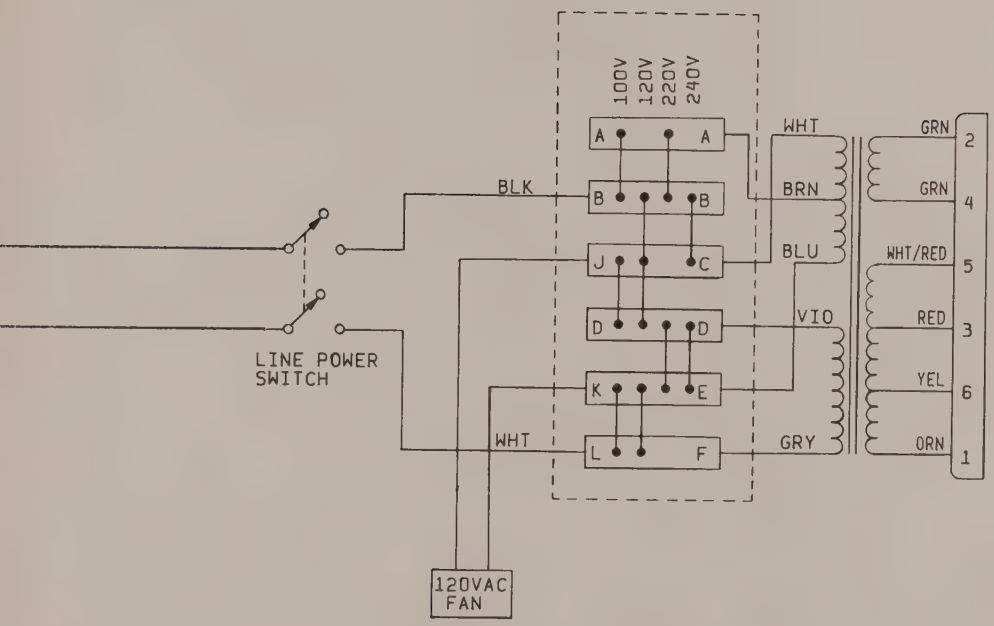


Figure 9-3. A1 Main PCB Assembly (cont)



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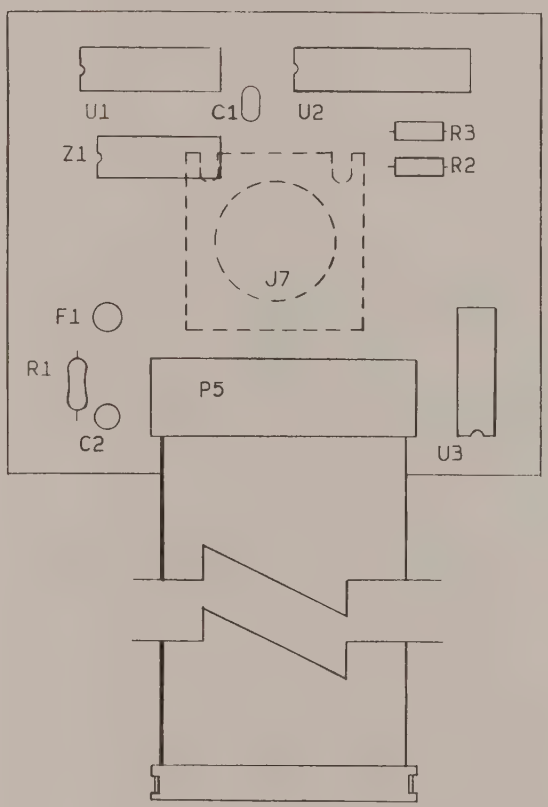
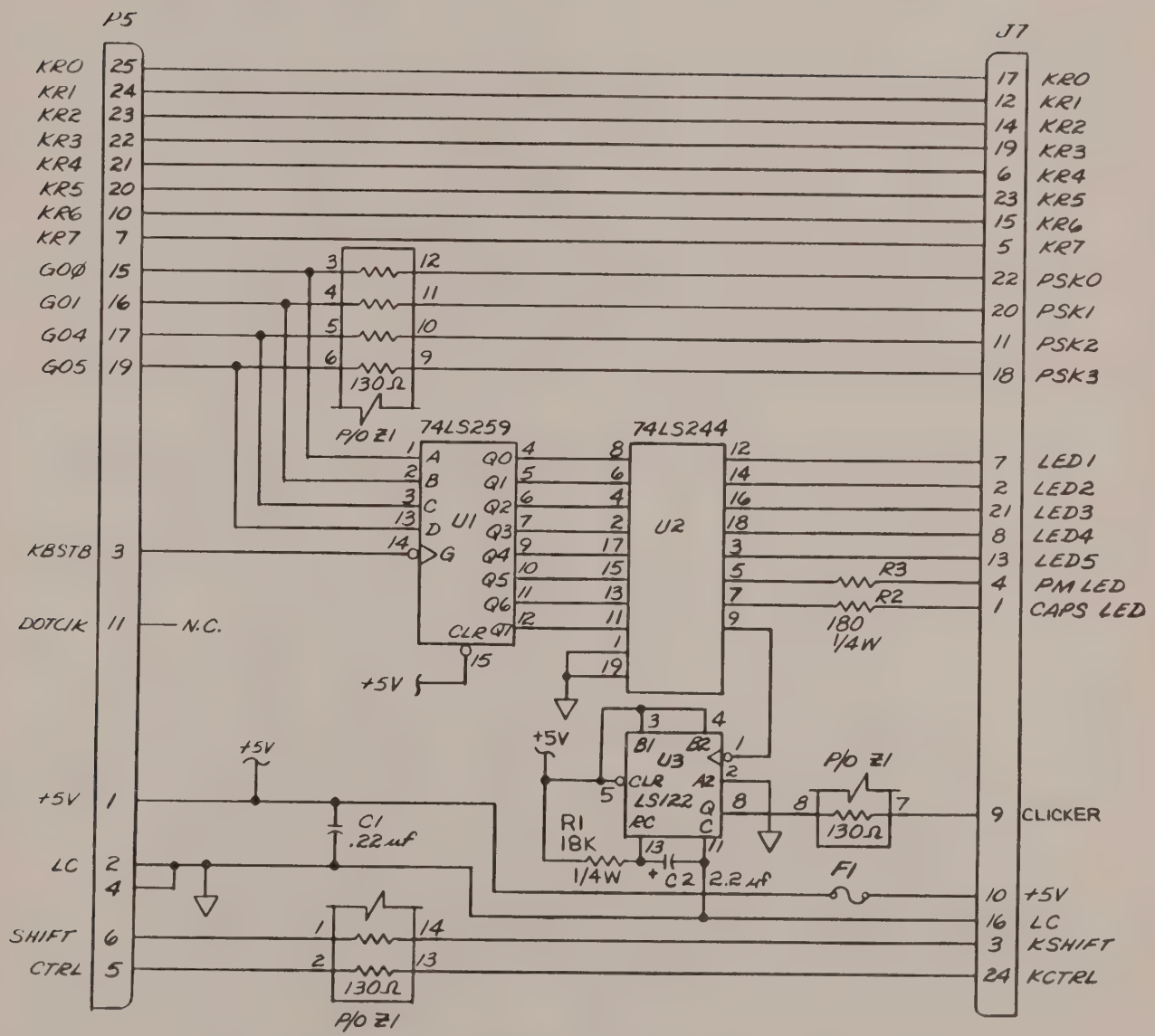
(Sheet 6 of 6)

Figure 9-3. A1 Main PCB Assembly (cont)



1780A-1603

Figure 9-4. 1780A-001 Keyboard Interface PCB Assembly

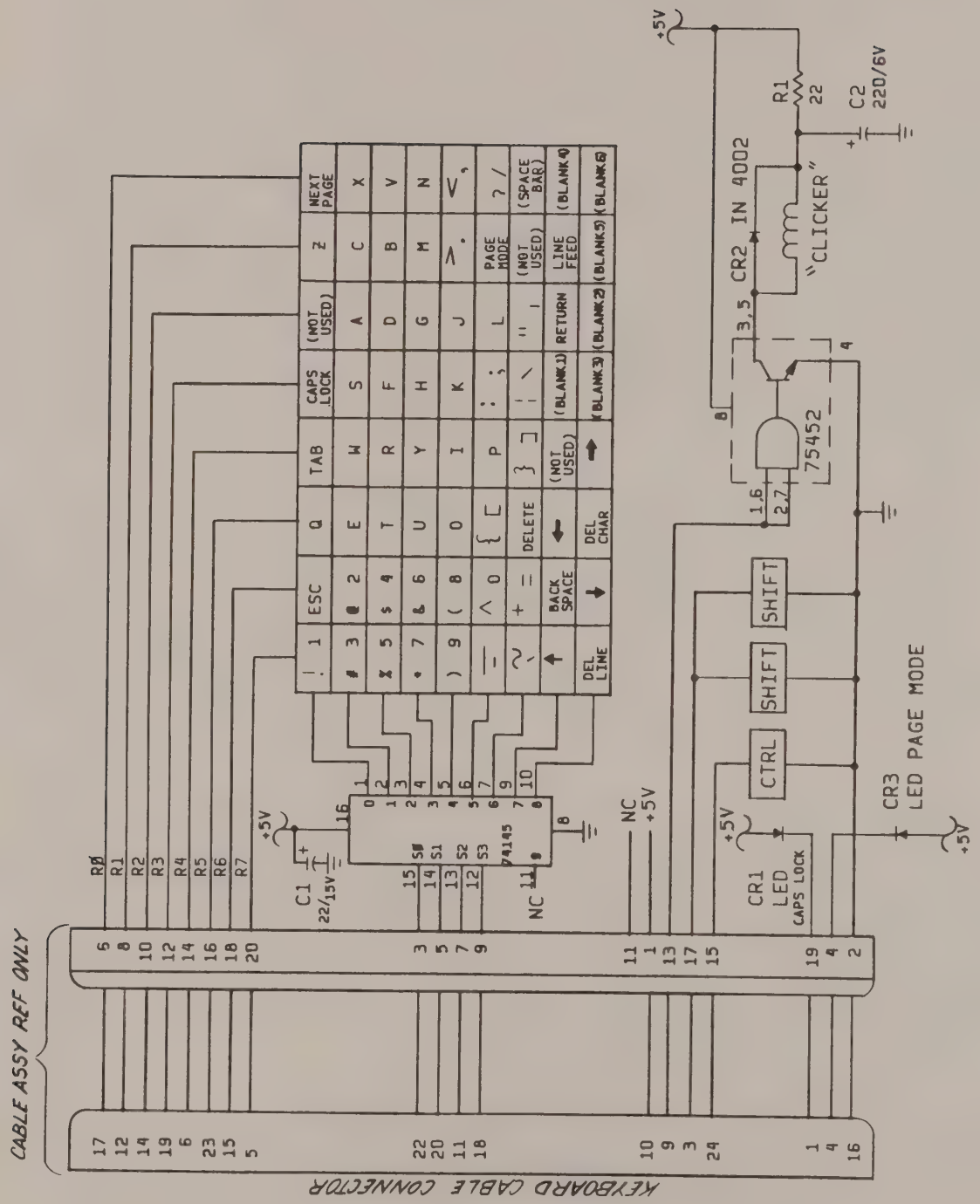


NOTES: UNLESS OTHERWISE SPECIFIED.

1. ALL CAPACITANCE IS IN MICROFARADS.
2. ALL RESISTANCE IS IN OHMS.

1780A-1003

Figure 9-4. 1780A-001 Keyboard Interface PCB Assembly (cont)



1720A-1010

Figure 9-5. Y1720 Programmer Keyboard PCB Assembly

The information in this appendix describes the interrelationships of data in the Character EPROM (U32), ASCII codes received as input, and the images displayed on the 1780A screen. This information and an EPROM programmer allow you to create custom character sets for your 1780A.

Character cell dot patterns are stored in either a 2716 or a 2732A type EPROM. The standard character set capacity is 128 characters. The alternate character set capability provides an additional 128 characters for a total of 256 characters. The 2732A is required for the alternate character set capability. In both the standard and the alternate character set modes, 116 characters can be displayed directly. The remaining 11 characters in each mode are displayed through the Standard Graphics Mode.

Each character cell is 8 dots wide by 14 dots high. Since every dot in each character cell can be displayed, all character codes are available for graphics.

CAUTION

In order to retain the ability to erase in the 1780A screen, leave character position 32 blank.

The rules by which standard ASCII display characters are defined follow. This information is provided for reference. You can design characters in any way you wish.

- Standard ASCII display characters are 9 dots high and up to 7 dots wide.
- The rightmost column is left blank.
- Capital letters observe the following rules:
  1. They start on row 2.
  2. They extend down to row 10.
  3. The topmost row is left blank.

- Lower case letters observe the following rules:

  1. They start at row 4.

  2. Characters without descenders extend down to row 10.

  3. Characters with descenders, such as y, extend down to row 13.

- Row 14 is reserved for underlines.

Sixteen bytes are reserved in the EPROM for each character cell. The first byte corresponds to the top row of dots in the cell. The fourteenth byte corresponds to the bottom row. The last two bytes are not used for character generation. However, these two bytes may be used for generation of vertical graphics.

The hexadecimal EPROM address of each byte is its ASCII code in hexadecimal followed by its byte number within the cell. For example, 312 is the EPROM address of the second row of character number 31. A 1-bit corresponds to a displayed dot when reverse video is disabled.

EXAMPLES

NOTES

In the following examples, all number are shown in hexadecimal.

The last two bytes are not used, even for graphics characters.

A capital H character (ASCII code 48 hex) is encoded as follows:

ADDRESS IN ROM	1780A DISPLAY	CODE BYTE
480	. . . . .	00
481	1 . . . . . 1 .	82
482	1 . . . . . 1 .	82
483	1 . . . . . 1 .	82
484	1 . . . . . 1 .	82
485	1 1 1 1 1 1 1 .	FE
486	1 . . . . . 1 .	82
487	1 . . . . . 1 .	82
488	1 . . . . . 1 .	82
489	1 . . . . . 1 .	82
48A	. . . . .	00
48B	. . . . .	00
48C	. . . . .	00
48D	. . . . .	00
48E	. . . . .	00
48F	. . . . .	00

A lower case y character (ASCII code 79 hex) is encoded as follows:

ADDRESS IN ROM	1780A DISPLAY	CODE BYTE
790	. . . . .	00
791	. . . . .	00
792	. . . . .	00
793	. . . . .	00
794	1 . . . . 1 . .	84
795	1 . . . . 1 . .	84
796	1 . . . . 1 . .	84
797	1 . . . 1 1 . .	8C
798	. 1 1 1 . 1 . .	74
799	. . . . . 1 . .	04
79A	. . . . . 1 . .	04
79B	1 . . . . 1 . .	84
79C	. 1 1 1 1 . . .	78
79D	. . . . .	00
79E	. . . . .	00
79F	. . . . .	00

A right intersect graphics character is encoded as follows. In this example, the graphics character is placed at ASCII code 0C0.

ADDRESS IN ROM	1780A DISPLAY	CODE BYTE
0C0	. . . 1	10
0C1	. . . 1	10
0C2	. . . 1	10
0C3	. . . 1	10
0C4	. . . 1	10
0C5	. . . 1	10
0C6	. . . 1 1 1 1 1	1F
0C7	. . . 1	10
0C8	. . . 1	10
0C9	. . . 1	10
0CA	. . . 1	10
0CB	. . . 1	10
0CC	. . . 1	10
0CD	. . . 1	10
0CE	. . . . .	00
0CF	. . . . .	00

THINGS TO KEEP IN MIND

The switch from primary to alternate character set occupies a space on the display screen. You should include all characters that must appear sequentially within either the standard or the alternate character set.

Thirteen character codes in each character set are interpreted as control codes. Character patterns stored in these locations can be displayed in the Standard Graphics Mode. To select the Standard Graphics Mode, send the sequence <ESC> [2 p to the 1780A.

In the Standard Graphics Mode, character patterns are selected for display from the EPROM start addresses listed in Table A-1.

Table A-1. Standard Graphics Mode Character EPROM Start Addresses

ASCII CHARACTER RECEIVED	EPROM PATTERN START ADDRESS (HEXADECIMAL)	
	STANDARD CHARACTER SET	ALTERNATE CHARACTER SET
0	000	800
1	070	870
2	080	880
3	090	890
4	0A0	8A0
5	0B0	8B0
6	0C0	8C0
7	0D0	8D0
8	0E0	8E0
9	0F0	8F0
:	110	910

CUSTOM CHARACTER SET EPROM INSTALLATION PROCEDURE

CAUTION

Changing this EPROM may violate your warranty if you damage the 1780A during the following procedure.

Complete the following procedure to install a custom character set EPROM:

1. Set the 1780A POWER switch to the 0 (off) position and disconnect line power.

2. Use the access procedures in Section 6 to access the Main PCB Assembly.

3. Use a proper IC installation tool to remove the standard character set EPROM (U32).

NOTE

Save this EPROM in case your 1780A needs repairs. The 1780A cannot be repaired without the standard character set EPROM. The Fluke Service Center will need it for proper diagnostic displays. If you return a 1780A for repair without a standard character set EPROM, you'll probably be charged for a new EPROM.

4. Use the IC installation tool to install the custom character set EPROM.

5. If the EPROM is type 2716, connect pin 21 to +5V as shown in Figure A-1.

6. If the EPROM is type 2732A, connect pin 21 to pin 34 of U33 as shown in Figure A-1. The Extended Graphics Character Set Option uses a 2732A type EPROM.

7. Use the assembly procedure in Section 6 to properly close the 1780A.

8. Connect line power and set the 1780A POWER switch to 1 (on).

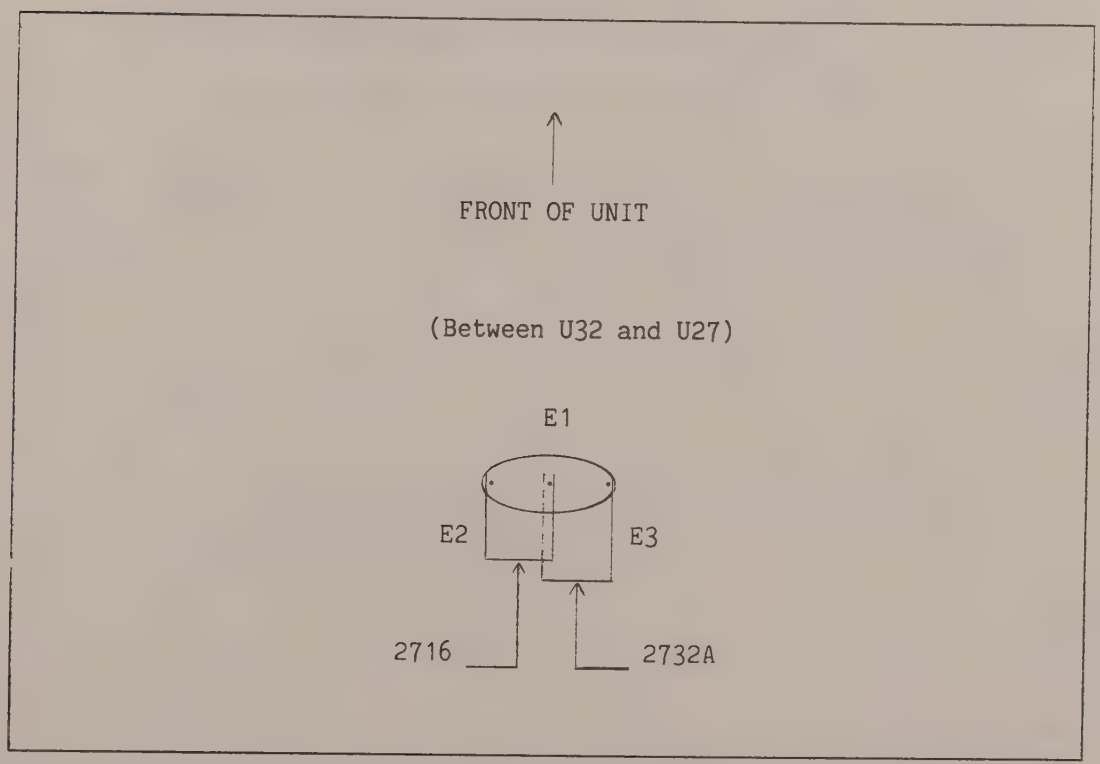


Figure A-1. Jumper Position For EPROM Type 2716 or 2732A

INTRODUCTION

This appendix contains information necessary to backdate the manual to conform with earlier pcb configurations. To identify the configuration of the pcb's used in your instrument, refer to the revision letter (marked in ink) on the component side of each pcb assembly. Table B-1 defines the assembly revision levels documented in this manual.

NEWER INSTRUMENTS

As changes and improvements are made to the instrument, they are identified by incrementing the revision letter marked on the affected pcb assembly. These changes are documented on a supplemental change/errata sheet which, when applicable, is inserted at the front of the manual.

OLDER INSTRUMENTS

To backdate this manual to conform with earlier assembly revision levels, perform the changes indicated in Table B-1.

Table B-1. Manual Status and Backdating Information

REF OR OPTION NO.	ASSEMBLY NAME	FLUKE PART NO.	*To adapt manual to earlier rev configurations perform changes in descending order (by no.), ending with changes under desired rev letter.														
			-	A	B	C	D	E	F	G	H	J	K	L	M	N	P
A1	MAIN PCB ASSEMBLY															X	

X = The PCB revision levels documented in this manual.
* = These revision levels were never used in this manual.
- = No revision letter on the pcb.
+ = Change did not affect the manual.

Appendix C
General Information

Federal Supply Codes for Manufacturers

00213
Nytronics Comp. Group Inc.
Subsidiary of Nytronics Inc.
Formerly Sage Electronics
Rochester, New York

00327
Welwyn International, Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc
Harrisburg, Pennsylvania

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc
Semiconductor Group
Dallas, Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics Inc
Manchester, New Hampshire

01730
Replaced by 73586

01884
Use 56289
Sprague Electric Co.
Dearborn Electronic Div.
Lockwood, Florida

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Harris ASW Div.
Westwood, Maine

02395
Rason Mfg. Co.
Brooklyn, New York

02533
Snelgrove, C.R. Co., Ltd.
Don Mills, Ontario, Canada
M3B 1M2

02606
Fenwal Labs
Div. of Travenal Labs
Morton Grove, Illinois

02660
Bunker Ramo Corp., Conn Div.
Formerly Amphenol-Borg
Electric Corp.
Broadview, Illinois

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products
Syracuse, New York

03614
Replaced by 71400

03651
Replaced by 44655

03797
Eldema Div.
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03888
KDI Pyrofilm Corp.
Whippany, New Jersey

03911
Clairex Electronics Div.
Clairex Corp.
Mt. Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Arrow Hart Inc.
Hartford, Connecticut

04062
Replaced by 72136

04202
Replaced by 81312

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, California

04221
Aemco, Div. of
Midtex Inc.
Mankato, Minnesota

04222
AVX Ceramics Div.
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04645
Replaced by 75376

04713
Motorola Inc. Semiconductor
Products
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05082
Replaced by 94988

05236
Jonathan Mfg Co.
Fullerton, California

05245
Components Corp. now
Corcom, Inc
Chicago, Illinois

05277
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05278
Replaced by 43543

05279
Southwest Machine &
Plastic Co.
Glendora, California

05397
Union Carbide Corp.
Materials Systems Div.
New York, New York

05571
Use 56289
Sprague Electric Co.
Pacific Div.
Los Angeles, California

05574
Viking Industries
Chatsworth, California

05704
Replaced by 16258

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Electronic Capacitor &
Battery Products Dept.
Columbia, South Carolina

06136
Replaced by 63743

06383
Panduit Corp
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Amphenol SAMS Div.
Chatsworth, California

06555
Beede Electrical Instrument Co.
Penacook, New Hampshire

06739
Electron Corp.
Littleton, Colorado

06743
Clevite Corp.
Cleveland, Ohio

06751
Components, Inc. Semcor Div
Phoenix, Arizona

06860
Gould Automotive Div
City of Industry, California

06961
Vernitron Corp., Piezo
Electric Div.
Formerly Clevite Corp., Piezo
Electric Div.
Bedford, Ohio

06980
Eimac Div.
Varian Associates
San Carlos, California

07047
The Ross Milton Co
South Hampton, Pennsylvania

07115
Replaced by 14674

07138
Westinghouse Electric Corp.,
Electronic Tube Div
Horsehead, New York

07233
TRW Electronic Components
Cinch Graphic
City of Industry, California

07256
Silicon Transistor Corp.
Div of BBF Group Inc.
Chelmsford, Massachusetts

07261
Aumet Corp.
Culver City, California

07263
Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp.
Mountain View, California

07344
Bircher Co., Inc.
Rochester, New York

07597
Burndy Corp.
Tape/Cable Div
Rochester, New York

07792
Lerma Engineering Corp
Northampton, Massachusetts

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

07933
Use 49956
Raytheon Co
Semiconductor Div HQ
Mountain View, California

08225
Industro Transistor Corp
Long Island City, New York

Federal Supply Codes for Manufacturers (cont)

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp
Brooklyn, New York

08806
General Electric Co.
Miniature Lamp Products Dept
Cleveland, Ohio

08863
Nylomatic Corp.
Norrisville, Pennsylvania

08988
Use 53085
Skottie Electronics Inc
Archbald, Pennsylvania

09214
G.E. Co. Semi-Conductor
Products Dept.
Power Semi-Conductor
Products OPN Sec.
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09423
Scientific Components, Inc.
Santa Barbara, California

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

10059
Barker Engineering Corp.
Formerly Amerace, Amerace
ESNA Corp.
Kenilworth, New Jersey

11236
CTS of Berne
Berne, Indiana

11237
CTS Keene Inc.
Paso Robles, California

11358
CBS Electronic Div.
Columbia Broadcasting System
Newburyport, Minnesota

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

11711
General Instrument Corp.
Rectifier Division
Hicksville, New York

11726
Qualidyne Corp.
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12040
National Semiconductor Corp.
Danburry, Connecticut

12060
Diodes, Inc.
Chatsworth, California

12136
Philadelphia Handle Co.
Camden, New Jersey

12300
Potter-Brumfield Div.
AMF Canada LTD.
Guelph, Ontario, Canada

12323
Presin Co., Inc.
Shelton, Connecticut

12327
Freeway Corp. formerly
Freeway Washer & Stamping Co.
Cleveland, Ohio

12443
The Budd Co. Polychem Products
Plastic Products Div.
Bridgeport, Pennsylvania

12615
U.S. Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co.
Dover, New Hampshire

12749
James Electronics
Chicago, Illinois

12856
Micrometals
Sierra Madre, California

12954
Dickson Electronics Corp.
Scottsdale, Arizona

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13511
Amphenol Cadre Div.
Bunker-Ramo Corp.
Los Gatos, California

13606
Use 56289
Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839
Replaced by 23732

14099
Semtech Corp.
Newbury Park, California

14140
Edison Electronic Div.
Mc Gray-Edison Co.
Manchester, New Hampshire

14193
Cal-R-Inc. formerly
California Resistor, Corp.
Santa Monica, California

14298
American Components, Inc.
an Insilco Co.
Conshohocken, Pennsylvania

14655
Cornell-Dublier Electronics
Division of Federal Pacific
Electric Co. Govt. Control Dept.
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14869
Replaced by 96853

14936
General Instrument Corp.
Semi Conductor Products Group
Hicksville, New York

15636
Elec-Trol Inc.
Saugus, California

15801
Fenwal Electronics Inc.
Div. of Kidde Walter and Co., Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors,
formerly Amelco Semiconductor
Mountain View, California

15849
Litton Systems Inc. Useco Div.
formerly Useco Inc.
Van Nuys, California

15898
International Business
Machines Corp.
Essex Junction, Vermont

15909
Replaced by 14140

16258
Space-Lok Inc.
Burbank, California

16299
Corning Glass
Electronic Components Div
Raleigh, North Carolina

16332
Replaced by 28478

16473
Cambridge Scientific Ind
Div. of Chemed Corporation
Cambridge, Maryland

16742
Paramount Plastics
Fabricators, Inc.
Downey, California

16758
Delco Electronics
Div. of General Motors Corp
Kokomo, Indiana

17001
Replaced by 71468

17069
Circuit Structures Lab
Burbank, California

17338
High Pressure Eng. Co., Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors, Inc.
Asbury Park, New Jersey

17856
Siliconix, Inc
Santa Clara, California

17870
Replaced by 14140

18178
Vactec Inc.
Maryland Heights, Missouri

18324
Signetics Corp.
Sunnyvale, California

18612
Vishay Resistor Products Div.
Vishay Intertechnology Inc
Malvern, Pennsylvania

18736
Voltronics Corp
Hanover, New Jersey

18927
GTE Sylvania Inc.
Precision Material Group
Parts Division
Titusville, Pennsylvania

19451
Perine Machinery & Supply Co
Seattle, Washington

19701
Electro-Midland Corp
Mepco-Electra Inc.
Mineral Wells, Texas

20584
Enochs Mfg Inc.
Indianapolis, Indiana

Federal Supply Codes for Manufacturers (cont)

20891
Self-Organizing Systems, Inc.
Dallas, Texas

21604
Bucheye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Transistor Division
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Inc.
Rockville, Maryland

23880
Stanford Applied Engrng.
Santa Clara, California

23936
Pamotor Div., Wm. J. Purdy Co.
Burlingame, California

24248
Replaced by 94222

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

24759
Lenox Fugle Electronics Inc.
South Plainfield, New Jersey

25088
Siemen Corp.
Isilen, New Jersey

25403
Amperex Electronic Corp.
Semiconductor &
Micro-Circuits Div.
Slatersville, Rhode Island

27014
National Semiconductor Corp.
Santa Clara, California

27264
Molex Products
Downers Grove, Illinois

28213
Minnesota Mining & Mfg. Co.
Consumer Products Div.
St Paul, Minnesota

28425
Serv-/-Link formerly
Bohannan Industries
Fort Worth, Texas

28478
Deltrol Controls Div
Deltrol Corporation
Milwaukee, Wisconsin

28480
Hewlett Packard Co.
Corporate HQ
Palo Alto, California

28520
Heyman Mfg. Co.
Kenilworth, New Jersey

29083
Monsanto, Co., Inc.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30148
AB Enterprise Inc.
Ahoskie, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

31091
Optimax Inc.
Colmar, Pennsylvania

32539
Mura Corp.
Great Neck, New York

32767
Griffith Plastic Corp.
Burlingame, California

32879
Advanced Mechanical
Components
Northridge, California

32897
Erie Technological Products, Inc.
Frequency Control Div.
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Products Division
Riverside, California

33173
General Electric Co.
Products Dept.
Owensboro, Kentucky

34333
Silicon General
Westminister, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc.
Kenilworth, New Jersey

37942
P.R. Mallory & Co., Inc.
Indianapolis, Indiana

42498
National Radio
Melrose, Massachusetts

43543
Nytronics Inc.
Transformer Co. Div.
Geneva, New York

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp.
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

54294
Cutler-Hammer Inc. formerly
Shallcross, A Cutter-Hammer Co.
Selma, North Carolina

55026
Simpson Electric Co.
Div. of Am. Gage and Mach. Co.
Elgin, Illinois

56289
Sprague Electric Co.
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

60399
Torin Corp. formerly
Torrington Mfg. Co.
Torrington, Connecticut

63743
Ward Leonard Electric Co., Inc.
Mount Vernon, New York

64834
West Mfg. Co.
San Francisco, California

65092
Weston Instruments Inc.
Newark, New Jersey

66150
Winslow Tele-Tronics Inc.
Eaton Town, New Jersey

70485
Atlantic India Rubber Works
Chicago, Illinois

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71002
Birnback Radio Co., Inc
Freeport, New York

71400
Bussmann Mfg.
Div. of McGraw-Edison Co.
Saint Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

71482
Clare, C.P. & Co.
Chicago, Illinois

71590
Centrelab Electronics
Div. of Globe Union Inc.
Milwaukee, Wisconsin

71707
Coto Coil Co., Inc.
Providence, Rhode Island

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Cinch Connector Operations Div.
Elk Grove Village
Chicago, Illinois

72005
Wilber B. Driver Co.
Newark, New Jersey

72092
Replaced by 06980

72136
Electro Motive Mfg. Co.
Williamantic, Connecticut

72259
Nytronics Inc.
Pelham Manor, New Jersey

72619
Dialight Div.
Amperex Electronic Corp.
Brooklyn, New York

72653
G.C. Electronics
Div. of Hydrometals, Inc.
Brooklyn, New York

72665
Replaced by 90303

72794
Dzus Fastener Co., Inc.
West Islip, New York

72928
Gulton Ind. Inc.
Gudeman Div.
Chicago, Illinois

Federal Supply Codes for Manufacturers (cont)

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Bechman Instrument Inc.
Helipot Division
Fullerton, California

73293
Hughes Aircraft Co.
Electron Dynamics Div.
Torrance, California

73445
Amperex Electronic Corp.
Hicksville, New York

73559
Carling Electric Inc.
West Hartford, Connecticut

73586
Circle F Industries
Trenton, New Jersey

73734
Federal Screw Products, Inc.
Chicago, Illinois

73743
Fischer Special Mfg. Co.
Cincinnati, Ohio

73899
JFD Electronics Co.
Components Corp.
Brooklyn, New York

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74199
Quan Nichols Co.
Chicago, Illinois

74217
Radio Switch Corp.
Marlboro, New Jersey

74276
Signalite Div.
General Instrument Corp.
Neptune, New Jersey

74306
Piezo Crystal Co.
Carlisle, Pennsylvania

74542
Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970
Johnson E.F., Co.
Waseca, Minnesota

75042
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75376
Kurz-Kasch Inc.
Dayton, Ohio

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

76854
Oak Industries Inc.
Switch Div.
Crystal Lake, Illinois

77342
AMF Inc.
Potter & Brumfield Div.
Princeton, Indiana

77638
General Instrument Corp.
Rectifier Division
Brooklyn, New York

77969
Rubbercraft Corp. of CA. LTD.
Torrance, California

78189
Shakeproof
Div. of Illinois Tool Works Inc.
Elgin, Illinois

78277
Sigma Instruments, Inc.
South Braintree, Massachusetts

78488
Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553
Eaton Corp. Engineered
Fastener Div.
Tinnerman Plant
Cleveland, Ohio

79136
Waldes Kohinoor Inc.
Long Island City, New York

79497
Western Rubber Company
Goshen, Indiana

79963
Zierick Mfg. Corp.
Mt. Kisko, New York

80031
Electro-Midland Corp.
Mepco Div.
A North American Phillips Co.
Norristown, New Jersey

80145
LFE Corp., Process Control Div.
formerly API Instrument Co.
Chesterland, Ohio

80183
Use 56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc., Instrument Div.
Riverside, California

80583
Hammarlund Mfg. Co., Inc.
Red Bank, New Jersey

80640
Arnold Stevens, Inc.
South Boston, Massachusetts

81073
Grayhill, Inc.
La Grange, Illinois

81312
Winchester Electronics
Div. of Litton Industries Inc.
Oakville, Connecticut

81483
Therm-O-Disc Inc.
Mansfield, Ohio

81483
International Rectifier Corp.
Los Angeles, California

81590
Korry Mfg. Co.
Seattle, Washington

81741
Chicago Lock Co.
Chicago, Illinois

82305
Palmer Electronics Corp.
South Gate, California

82389
Switchcraft Inc.
Chicago, Illinois

82415
North American Phillips
Controls Corp.
Frederick, Maryland

82872
Roanwell Corp.
New York, New York

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div.
Pawtucket, Rhode Island

83003
Varo Inc.
Garland, Texas

83058
The Carr Co., United Can Div.
of TRW
Cambridge, Massachusetts

83298
Bendix Corp.
Electric Power Div.
Eatontown, New Jersey

83330
Herman H. Smith, Inc.
Brooklyn, New York

83478
Rubbercraft Corp.
of America, Inc.
West Haven, Connecticut

83594
Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740
Union Carbide Corp
Battery Products Div
formerly Consumer Products Div
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
TRW Capacitors
Ogallala, Nebraska

84613
Fuse Indicator Corp.
Rockville, Maryland

84682
Essex International Inc.
Industrial Wire Div
Peabody, Massachusetts

86577
Precision Metal Products
of Malden Inc
Stoneham, Massachusetts

86684
Radio Corp. of America
Electronic Components Div.
Harrison, New Jersey

86928
Seastrom Mfg. Co., Inc
Glendale, California

87034
Illuminated Products Inc.
Subsidiary of Oak Industries Inc.
Anahiem, California

88219
Gould Inc
Industrial Div.
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div.
Van Nuys, California

88419
Cornell-Dubilier Electronic Div.
Federal Pacific Co.
Fuquay-Varian, North Carolina

88486
Plastic Wire & Cable
Jewitt City, Connecticut

88690
Replaced by 04217

89536
John Fluke Mfg. Co., Inc
Seattle, Washington

89730
G.E. Co., Newark Lamp Works
Newark, New Jersey

Federal Supply Codes for Manufacturers (cont)

90201
Mallory Capacitor Co.
Div. of P.R. Mallory Co., Inc.
Indianapolis, Indiana

90211
Use 56365
Square D Co.
Chicago, Illinois

90215
Best Stamp & Mfg. Co.
Kansas City, Missouri

90303
Mallory Battery Co.
Div. of Mallory Co., Inc.
Tarrytown, New York

91094
Essex International Inc.
Suglex/IWP Div.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91407
Replaced by 58474

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

91737
Use 71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices, Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91836
King's Electronics Co., Inc.
Tuckahoe, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934
Miller Electric Co., Inc.
Div. of Aunet
Woonsocket, Rhode Island

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145
Replaced by 49956

94154
Use 94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

94222
Southco Inc. formerly
South Chester Corp.
Lester, Pennsylvania

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

95263
Leecraft Mfg. Co.
Long Island City, New York

95264
Replaced by 98278

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95354
Methode Mfg. Corp.
Rolling Meadows, Illinois

95712
Bendix Corp.
Electrical Components Div.
Microwave Devices Plant
Franklin, Indiana

95987
Weckesser Co. Inc.
Chicago, Illinois

96733
San Fernando Electric Mfg. Co.
San Fernando, California

96853
Gulton Industries Inc.
Measurement and Controls Div.
formerly Rustrak Instruments Co.
Manchester, New Hampshire

96881
Thomson Industries, Inc.
Manhasset, New York

97540
Master Mobile Mounts, Div. of
Whitehall Electronics Corp.
Ft. Meyers, Florida

97913
Industrial Electronic
Hardware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

97966
Replaced by 11358

98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
Malco A Microdot Co., Inc.
Connector & Cable Div.
Pasadena, California

98291
Sealectro Corp.
Mamaroneck, New York

98388
Royal Industries
Products Div.
San Diego, California

98743
Replaced by 12749

98925
Replaced by 14433

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect.
Comp. Div.
formerly Southern Elect. Div.
Burbank, California

99392
STM
Oakland, California

99515
ITT Jennings Monrovia Plant
Div. of ITT Jennings formerly
Marshall Industries Capacitor Div.
Monrovia, California

99779
Use 29587
Bunker-Ramo Corp.
Barnes Div.
Landsdowne, Pennsylvania

99800
American Precision Industries Inc.
Delevan Division
East Aurora, New York

99942
Centrelab Semiconductor
Centrelab Electronics Div. of
Globe-Union Inc.
El Monte, California

Toyo Electronics
(R-Ohm Corp.)
Irvine, California

National Connector
Minneapolis, Minnesota

U.S. SALES AREAS for all Fluke products

AL, Huntsville
John Fluke Mfg. Co., Inc.
4920 Corporate Drive
Suite J
Huntsville, AL 35805-6202
(205) 830-9671

AZ, Tempe
John Fluke Mfg. Co., Inc.
2211 S. 48th Street
Suite B
Tempe, AZ 85282
(602) 438-8314

CA, Burbank
John Fluke Mfg. Co., Inc.
2020 N. Lincoln Street
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Instrimpex - Fluke Service Center
Tel: 65-7281

Colombia, Bogota
Sistemas E Instrumentacion, Ltda.
Tel: 232-4532
TLX: (396) 45787

Denmark, Ballerup
Tage Olson A/S
Tel: 658111
TLX: (855) 35293

Ecuador, Quito
Proteco Coasin Cia., Ltda.
Tel: 526759
TLX: (393) 2865

Egypt and Sudan
Electronic Engineering Liaison Office
Tel: 695705
TLX: (927) 22782

England, Watford, Herts
Fluke (Great Britain) LTD
Tel: 40511
TLX: (851) 934583

Finland
Instrumentarium Elektronikka
Tel: 358-0-5281
TLX: (857) 124426

France
M.B. Electronique S.A.
Tel: 9568131
TLX: (842) 695414

Greece, Athens
Hellenic Scientific Representations
Tel: 7211140
TLX: (863) 219330

Hong Kong, Wanchai
Schmidt & Co (H.K.) Ltd.
Tel: 8330-222
TLX: (780) 74766

India, Bangalore
Hinditron Services Pvt. Ltd.
Tel: 33139
TLX: (953) 845741

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Hinditron Services Pvt. Ltd.
Tel: 8121316
TLX: (953) 112326

India, New Delhi
Hinditron Services Pvt. Ltd.
Tel: 640380
TLX: (953) 316458

Indonesia, Jakarta Pusat
P.T. Dwi Tunggal Jaya Sakti
Tel: 584685
TLX: (796) 47308

Israel, Ramat Hasharon
R.D.T. Electronics Engineering Ltd.
Tel: 483211
TLX: (922) 32143

Italy, Milan
Sistrel S.p.A.
Tel: 6181893
TLX: (843) 334643

Japan, Tokyo
John Fluke Mfg. Co., Inc.
Japan Branch
Tel: 434-0181
TLX: (781) 242-4331

Korea, Republic of
Electro-Science Korea Co.
Tel: 784-9942
TLX: MYOUNG K24283

Malaysia, Petaling Jaya
Mecomb Malaysia SDN BHD
Tel: 743422
TLX: (784) MA37764

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Colonia del Valle
C.P. 03100, Mexico
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TLX: (383) 1771038

Netherlands, Tilburg
Fluke (Nederland) B.V.
Tel: 352455
TLX: (844) 52683

New Zealand, Auckland
McLean Information Technology, Ltd.
Tel: 501-801, 501-219
TLX: (791) 21570

Norway, Oslo
Morgenstierne & Co. A/S
Tel: 356110
TLX: (856) 71719

Pakistan, Karachi
International Operations (PAK), Ltd.
Tel: 221127, 239052
TLX: (952) 24494

Peru, Lima
Importaciones Y Representaciones
Electronicas S.A.
Tel: 288650
TLX: (394) 25663

Philippines, Republic of
Spark Radio & Electronics Corp.
Tel: 775192
TLX: (722) 27901

Portugal, Lisbon
Decada Espectral Equipamentos
de Electronica, Lda.
Tel: 2103420
TLX: (832) 15515

Republic of Singapore, Singapore
Rank O'Connor's (PTE) Limited
Tel: 4737944
TLX: (786) RS21023

Republic of South Africa
Fluke S.A. (Pty) Ltd.
Tel: 786-3170
TLX: (960) 424328

Spain, Madrid
Equipos y Sistemas S.A.
Tel: 458-0150
TLX: (831) 42856

Sweden, Vallingby
Teleinstrument AB
Tel: 380370
TLX: (854) 15770

Switzerland, Zurich
Traco Electronic AG
Tel: 2010711
TLX: (845) 815570

Taiwan, Taipei
Schmidt Electronics Corp.
Tel: 5013468
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Thailand, Bangkok
Measuretronix Ltd.
Tel: 378-2516
TLX: (788) 82796

Turkey, Istanbul
Erkman Elektronik Aletler
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TLX: (821) 24399

Uruguay, Montevideo
Coasin Uruguaya S.A.
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Fluke (Deutschland) GmbH
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SERVICE MANUAL

CRT DATA DISPLAY

BC/BCX-200/300

5-017-1049

REV A

JUNE 1982

Ball Electronic Systems Division

BALL ELECTRONIC DISPLAY DIVISION P.O. BOX 43376 • ST. PAUL, MINNESOTA 55164 • TELEPHONE: (612) 786-8900 • TWX: 910-563-3552

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SECTION 1

GENERAL INFORMATION

1.1 MONITOR DESCRIPTION

BC Series 200/300 are solid-state, raster-scan displays for data terminal applications. They are engineered for high quality display of alphanumeric dot characters.

The four basic models are:

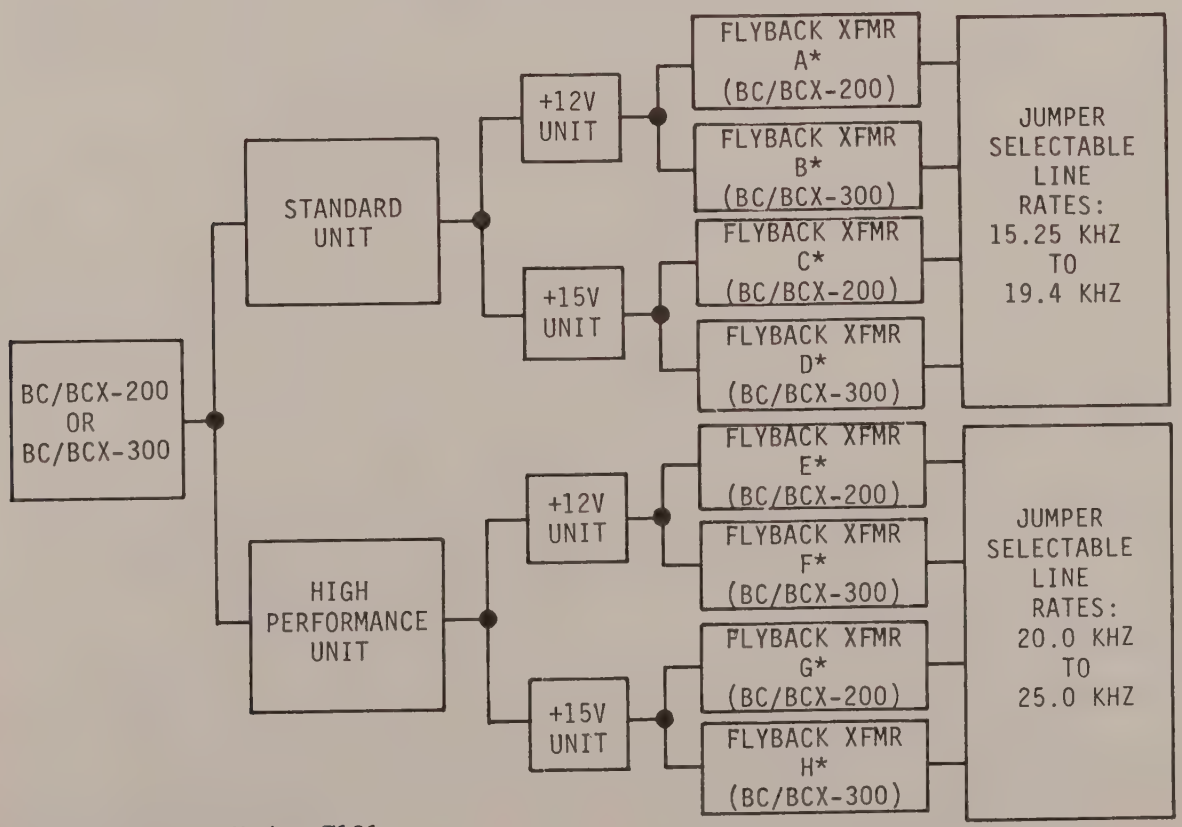
a. BC-200: 12-inch diagonal CRT (90° deflection angle); adjustable tilt metal frame; high performance horizontal oscillator with centering and hold controls. See Figure 1-1 for dimensions.

b. BCX-200: Identical to BC-200 except no metal frame is furnished. See Figure 1-1 for dimensions.

c. BC-300: Identical to BC-200 except CRT is 14-inch diagonal (90° deflection angle). See Figure 1-1 for dimensions.

d. BCX-300: Identical to BC-300 except no metal frame is furnished. See Figure 1-1 for dimensions.

Optional variations for these basic models include:



*See Parts List Under T101

1.2 CUSTOMER INPUTS

1.2.1 VIDEO

Amplitude: 4.0 ± 1.5 volts (into external 500 ohm or less contrast control), white positive
Rise Time: 10ns maximum leading edge (10-90%)
Fall Time: 10ns maximum trailing edge (90-10%)
Frequency: Standard unit.....up to 20 MHz data rate
High Performance unit...up to 25 MHz data rate
Duty Cycle: 50% minimum

1.2.2 HORIZONTAL DRIVE, See Figure 1-2

Amplitude: 4.0 ± 1.5 volts, sync positive
Rise/Fall Times: 50ns maximum
Frequency: Standard unit.....low line rate = 15.75 ± 0.5 kHz
high line rate = 18.40 ± 1.0 kHz
High Performance unit...low line rate = 21.00 ± 1.0 kHz
high line rate = 24.00 ± 1.0 kHz
Pulse Width: Standard unit.....2.5-40us
High Performance unit....2.5-32us
Blanking Time: Standard unit.....10us minimum
High Peformance Unit...8us minimum

1.2.3 VERTICAL DRIVE, See Figure 1-3

Amplitude: 4.0 ± 1.5 volts, sync positive or negative
Rise/Fall Times: 100ns maximum
Frequency: 47-82Hz
Pulse Width: 75us to ≤ vertical blanking time minus sync delay
Blanking Time: 850us

1.2.4 POWER

+12V or +15V
Standard Unit: 1.25 amperes nominal
1.50 amperes maximum
High Performance Unit: 1.50 amperes nominal
1.75 amperes maximum
Maximum Ripple: 100mv p-p for refresh synchronous with power supply
10mv p-p for refresh non-synchronous with power supply
50mv p-p for high frequency power

1.3 INPUT IMPEDANCE

1.3.1 VIDEO

Shunt Resistance: 4 kohms minimum (excluding internal contrast control)
Shunt Capacitance: 30pF maximum

1.3.2 HORIZONTAL DRIVE

Input Impedance: capacitively coupled 470 ohms minimum

1.3.3 VERTICAL DRIVE

Input impedance: 3.3 kohms minimum

1.4 VIDEO AMPLIFIER RESPONSE, See Figure 1-4

Small Signal Bandwidth (-3db):
Standard Unit: dc to 22 MHz (typical), 20 MHz (minimum)
High Performance Unit: dc to 27 MHz (typical), 25 MHz (minimum)
Leading Edge (90-10% at CRT cathode):
Standard Unit: 20ns maximum
High Performance Unit: 16ns maximum
Trailing Edge (10-70% at CRT Cathode):
Standard Unit: 20ns maximum
High Performance Unit: 16ns maximum

1.5 CONTROLS

1.5.1 INTERNAL, FACTORY PRESET

FUNCTION		LABEL ON PC BOARD
Horizontal:	Hold	HORIZ HOLD
	Video Centering	HORIZ CENT
	Linearity	LINEARITY
	Width	WIDTH
Vertical:	Hold	VERT HOLD
	Linearity	VERT LIN
	Height	HEIGHT
Focus		FOCUS
Brightness (limiting)		BRT
Contrast (optional)		CTRS

1.5.2 EXTERNAL, CUSTOMER SUPPLIED

Brightness (100 kohm potentiometer)
Contrast (500 ohm potentiometer)

1.6 DISPLAY CHARACTERISTICS

1.6.1 CRT DIAGONAL MEASUREMENT

BC/BCX-200: 12 inches
BC/BCX-300: 14 inches

1.6.2 CRT DEFLECTION ANGLE: 90^{o}

1.6.3 CRT TYPE

BC/BCX-200: 20 or 25 inch spherical radius
BC/BCX-300: 30 inch spherical radius

1.6.4 CERTIFICATION

1.6.4.1 Underwriters Laboratory (UL)

Shall be listed as Recognized Components that satisfy UL-478 Standard for Electronic Data Processing Units and Systems. Reference File No. E59318

1.6.4.2 Canadian Standards Association (CSA)

Shall be listed under CSA Standard C22.2, No. 154. Reference File No. 39422

1.6.5 HIGH VOLTAGE

BC/BCX-200: 13.0 kV (nominal)
BC/BCX-300: 14.5 kV (nominal)

1.6.6 USEABLE SCREEN AREA

BC/BCX-200: 6.7 X 9.0 inches
BC/BCX-300: 7.0 X 10.0 inches

1.6.7 HORIZONTAL RESOLUTION*

BC/BCX-200: 900 @ 40 fL (center)
750 @ 40 fL (corners)

BC/BCX-300: 1000 @ 40 fL (center)
900 @ 40 fL (corners)

*Resolution (in TV lines) for standard CRT (P4, non-etched, no bonded panel). Measured per EIA RS-375 except depth of modulation is set to 100%. Reference white is set to indicated luminance with contrast control and reference black is set to visual cut-off with brightness control.

1.6.8 GEOMETRIC DISTORTION

Pincushion distortion and sweep non-linearities are controlled to exceed requirement of EIA STD RS-375.

1.6.9 LINEARITY

Character height or width within 10% of that for any adjacent character and within 20% of that for any character on screen.

1.7 DATA DISPLAY TIMING

1.7.1 HORIZONTAL/VIDEO, See Figure 1-2

1.7.2 VERTICAL/VIDEO, See Figure 1-3

1.8 MECHANICAL SPECIFICATIONS

1.8.1 WEIGHT

BC-200: 10.0 lbs. (4.54 kg.)
BCX-200: 8.0 lbs. (3.63 kg.)
BC-300: 11.3 lbs. (5.20 kg.)
BCX-300: 9.3 lbs. (4.20 kg.)

1.8.2 DIMENSIONS, See Figure 1-1

1.9 ENVIRONMENTAL

	OPERATING	NON-OPERATING
Ambient Temperature	5 to 55°C (41 to 131°F)	-40 to 65°C (-40 to 150°F)
Humidity (non-condensing)	5 to 90%	5 to 90%
Altitude (maximum)	10,000 ft. (3.048 km)	30,000 ft. (9.144 km)

1.10 X-RADIATION

Complies with U.L. Standard 478 on x-radiation when operated within specified input voltage limits.

1.11 WARNINGS

1.11.1 HIGH VOLTAGES

High voltage may be present on CRT anode even when Monitor is not operating. Flyback transformer (T101) generates high voltages during Monitor operation. Any conductive material which is placed close to transformer case can cause an arc to jump the gap between case and conductive material. This occurs when the air gap ionizes and becomes a conductive path.

1.11.2 CRT

Handle CRT with care. Since CRT contains high vacuum, breakage may cause injury from flying glass. Do not hit or scratch CRT. Do not subject CRT to more than moderate pressure. Safety glasses should be worn when removing or installing CRT. Do not hold CRT by neck since pressure on neck may cause CRT breakage.

Discharge CRT high voltage anode before servicing Monitor. Following procedure is recommended:

Equipment Required:

1 - clip lead with alligator clips, both ends.
1 - flat-blade screwdriver with long, thin shaft and insulated handle. Insure handle is clean and free from any foreign material.

1.11.2 CRT (CONT.)

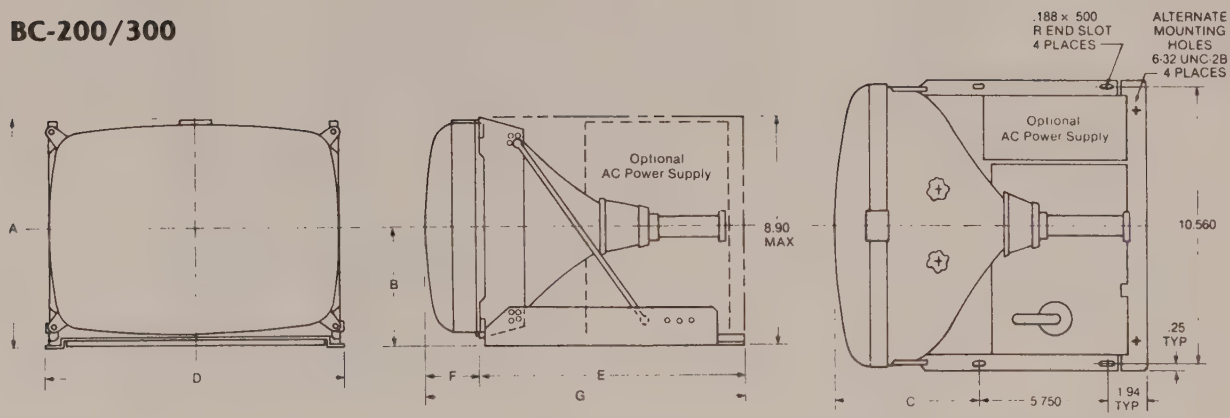
a. Completely disconnect Monitor.
b. Attach one end of clip lead to aquadag spring.
c. Attach other end of clip lead to center portion of screwdriver shaft.
d. Grasp screwdriver handle well away from screwdriver shaft. Use one hand only. Throughout discharge procedure, do not touch anything with free hand.
e. Slip screwdriver blade between anode cap and CRT. Anode cap may tend to stick making it necessary to gently pry up edge of cap.
f. Carefully push screwdriver blade to center of anode cap and touch blade to metal anode. A noticeable spark will generally result.
g. Screwdriver-anode contact must be maintained for a minimum of five (5) seconds.
h. Anode cap may be safely removed at this point.

1.11.3 X-RADIATION

Replacing T101 with a transformer of different design or manufacture may result in x-radiation in excess of minimum safety levels.

Supplying Monitor with excessive voltage (outside of specifications) may also increase x-radiation beyond minimum safety levels.

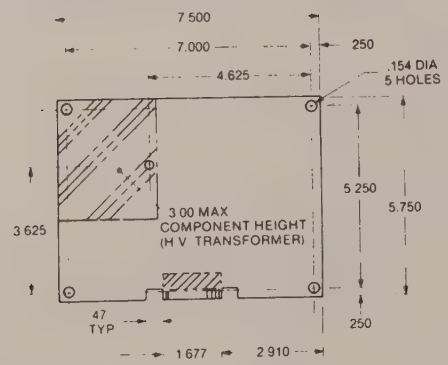
BC-200/300

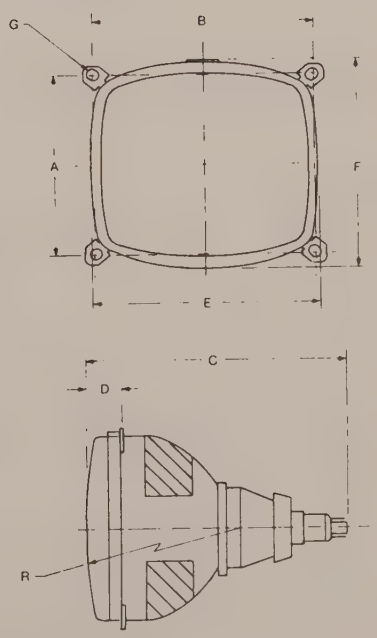


TILT	A				B				C				D	E	F	G
	0°	5°	7.5°	10°	0°	5°	7.5°	10°	0°	5°	7.5°	10°				
BC-200*	9.23	9.23	9.23	9.23	4.50	4.65	4.72	4.77	4.16	3.80	3.62	3.43	11.50	10.12	2.00 or 1.75	12.20
BC-300	10.50	10.50	10.50	10.50	5.31	5.58	5.70	5.82	5.27	4.84	4.62	4.38	12.50	11.13	1.83	13.28

*Dimension C is with standard 25-inch spherical radius CRT, add .28 inch for optional 20-inch spherical radius CRT.

BCX-200/BCX-300



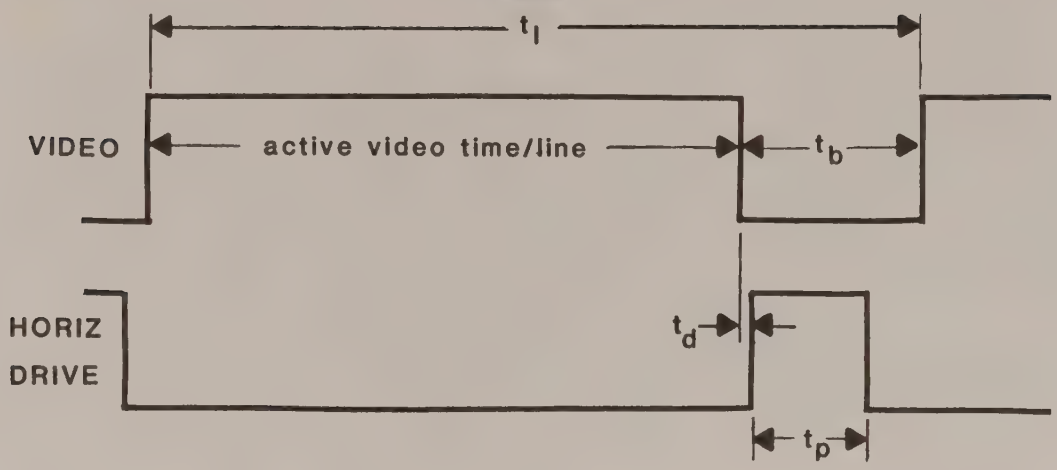


Diagonal Measure	R	A	B	C	D	E	F*	G
12"	20.0	7.49	10.76	11.43	2.00	11.1	9.25	.394 dia. or .296 x .388 R-END SLOT
	25.0	7.49	10.76	11.36	1.75	11.1	8.94	.275 x .354 R-END SLOT
14"	30.3	9.12	11.43	12.09	1.83	11.8	9.64	.394 SQ

*Includes CRT band clip, which may be on either the top or the bottom.

DIMENSIONS

Figure 1-1



t_l = time between lines = $\frac{1}{\text{horizontal line rate}}$

STANDARD UNIT

Low Line Rate

$$\frac{1}{16{,}250\ \text{Hz}} \leq t_l \leq \frac{1}{15{,}250\ \text{Hz}}$$

$$t_l\ (\text{typ.}) = \frac{1}{15{,}750\ \text{Hz}} = 63.49\ \mu\text{s}$$

High Line Rate

$$\frac{1}{19{,}400\ \text{Hz}} \leq t_l \leq \frac{1}{17{,}400\ \text{Hz}}$$

$$t_l\ (\text{typ.}) = \frac{1}{18{,}400\ \text{Hz}} = 54.35\ \mu\text{s}$$

HIGH PERFORMANCE UNIT

Low Line Rate

$$\frac{1}{22{,}000\ \text{Hz}} \leq t_l \leq \frac{1}{20{,}000\ \text{Hz}}$$

$$t_l\ (\text{typ.}) = \frac{1}{21{,}000\ \text{Hz}} = 47.62\ \mu\text{s}$$

High Line Rate

$$\frac{1}{25{,}000\ \text{Hz}} \leq t_l \leq \frac{1}{23{,}000\ \text{Hz}}$$

$$t_l\ (\text{typ.}) = \frac{1}{24{,}000\ \text{Hz}} = 41.67\ \mu\text{s}$$

t_d = sync delay: $-1\ \mu\text{s} \leq t_d \leq 3\ \mu\text{s}$

t_p = sync pulse width: $2.5\ \mu\text{s} \leq t_p \leq 40\ \mu\text{s}$

t_b = blanking time:

Standard Unit: 10 µs minimum

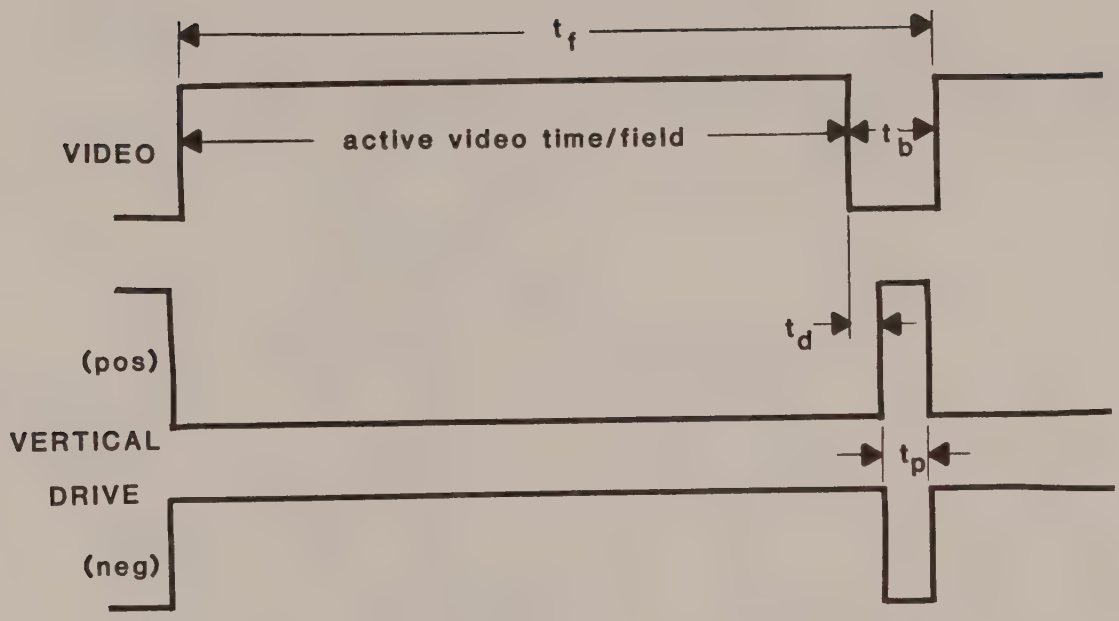
High Performance Unit: 8 µs minimum

NOTE: To minimize crosstalk between Horizontal Drive and active Video, pulse width should occur during blanking time, i.e.:

$t_d \geq 0$ and $t_d + t_b \leq t_b$

HORIZONTAL/VIDEO TIMING

Figure 1-2



t_f = time between fields: $\frac{1}{82\ Hz} \leq t_f \leq \frac{1}{47\ Hz}$

$$t_f\ (typ) = \frac{1}{60\ Hz} = 16.7\ ms$$

t_b = blanking time: 2 ms nominal, 850 µs minimum

t_d = sync delay... selected for best video centering within raster, per:

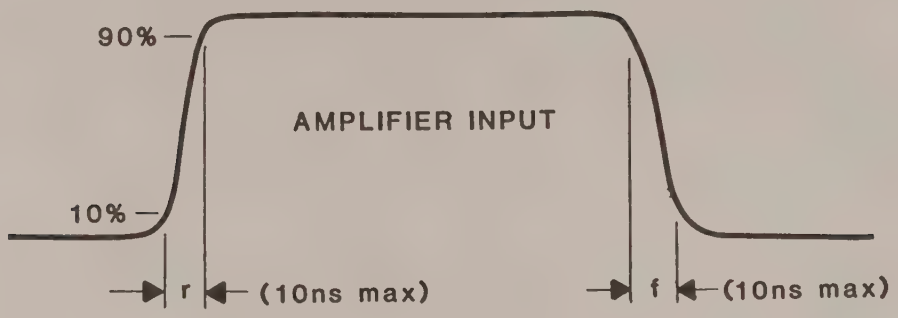
$$t_d = \frac{t_b - 850\ \mu s}{2}$$

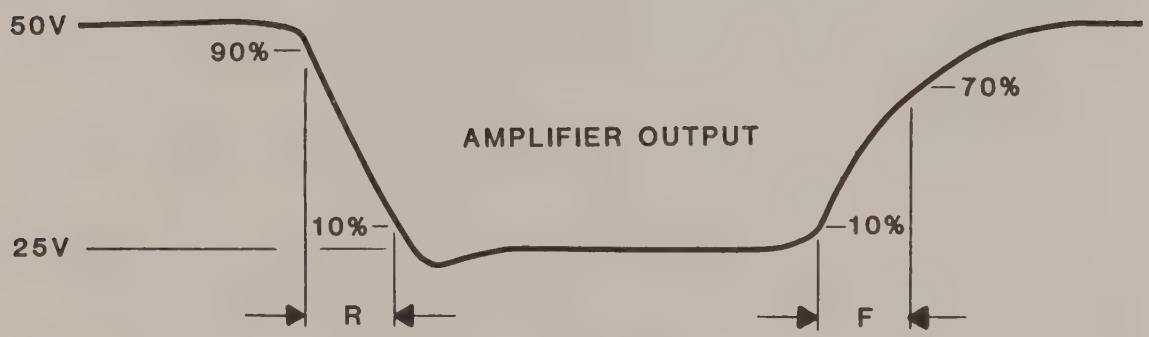
t_p = sync pulse width: $75\ \mu s \leq t_p \leq t_b - t_d$

VERTICAL/VIDEO TIMING

Figure 1-3

LARGE SIGNAL RISE & FALL TIME:





$$\text{amp rise time} = \sqrt{R^2 - r^2} \quad \leq 20 \text{ ns (Standard Unit)}$$
$$\leq 16 \text{ ns (High Performance Unit)}$$

$$\text{amp fall time} = \sqrt{F^2 - f^2} \quad \leq 20 \text{ ns (Standard Unit)}$$
$$\leq 16 \text{ ns (High Performance Unit)}$$

VIDEO AMPLIFIER RESPONSE

Figure 1-4

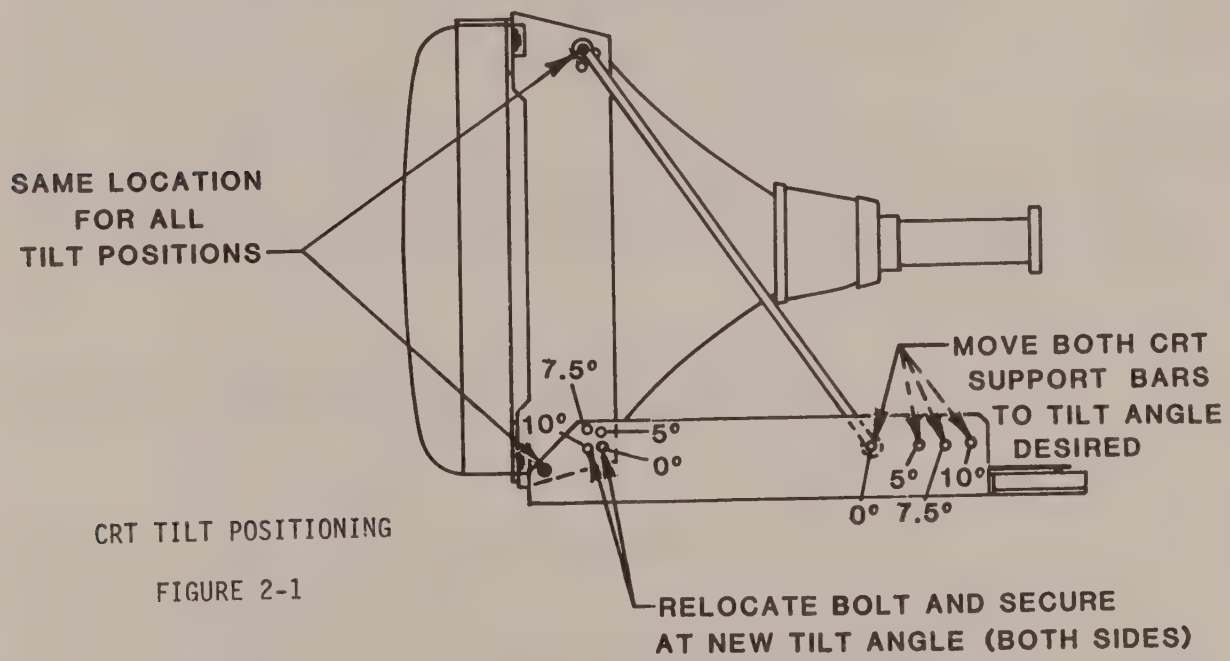
SECTION 2

INSTALLATION

2.1 MECHANICAL

2.1 BC-200/300

Units with adjustable tilt metal frames have four standard mounting holes in the chassis. See Figure 1-1 for dimensions. Four alternate mounting locations are identified by + signs. Tilt angle (factory set at 0^{o}) can be set to three other values:



CRT TILT POSITIONING

FIGURE 2-1

2.1.2 BCX-200/300

The Printed Wiring Assembly (PWA) provides five mounting holes. See Figure 1-1 for hole spacing data. Locate PWA so Flyback Transformer (T101) has no conductive material closer than 3/8 inch.

2.2 ELECTRICAL

2.2.1 INPUT

Units are supplied with standard ten-contact, board-edge connector (J101) or with an optional ten-pin connector (J106) which matches J101 (functionally) pin for pin.

2.2.1.1. Suggested Mating Connectors

For J101: Viking 2VK10S/1-2
Amphenol 225-21031-101

2.2.1.1 Suggested Mating Connectors (Cont.)

For J106:

Optional Mass Termination Connector: Molex No. 22-01-2107 with type No. 2579 contacts for discrete wires, or Amp. No. 1-640440-0, preloaded for mass termination.

2.2.1.2 Contact Identification, DC Models

For J101 or J106:

1 - Horizontal Ground
2,3,4 - External Brightness Control: See note 4, Figure 4-1
5 - Arc Ground
6 - Horizontal Drive
7 - +12 Volts
8 - Video
9 - Vertical Drive
10 - Video/Vertical Ground

2.2.1.3 Contact Identification, AC Models (With Power Supply)

For J101 or J106:

1 - Horizontal Ground
2,3,4 - External Brightness Control: See note 4, Figure 4-1
5 - Arc Ground
6 - Horizontal Drive
7 - Not Used
8 - Video
9 - Vertical Drive
10 - Video/Vertical Ground

For J104:

1 - Not Used
2 - +12 volts/+15 volts/ac for CRT heater
3,4 - Ground
5 - +12 volts/+15 volts

2.2.2 VIDEO

Video input line should be short as possible and separated from all other wiring.

2.2.3 GROUNDING

Video/Vertical Ground and Horizontal Ground are connected on the PWA. If desired, the two grounds can be separated by removing jumper wire W104 located about one inch from J101.

SECTION 3

ALINEMENT

Data displays are factory alined and should require no further adjustment. Following information is provided for future reference.

3.1 PRELIMINARY

a. Insure correct input voltage.
b. Insure correct input signals.
c. Insure P107 (for line rate), if used, is in correct position.
d. Insure P108 (for G2 voltage), if used, is in correct position.

3.2 ALINEMENT

3.2.1 HORIZONTAL HOLD

a. Rotate HORIZ HOLD (R145) in both directions to locate range of adjustment where sync is present. (Loss of sync should occur at both ends of this range.)
b. Set HORIZ HOLD to center of sync range.

3.2.2 VERTICAL HOLD

a. Rotate VERT HOLD (R106) fully counter-clockwise.
b. Rotate VERT HOLD clockwise to point where CRT picture begins to roll down.
c. Set VERT HOLD 1/8 turn counter-clockwise.

3.2.3 RASTER CENTERING

Set ring magnets on rear of yoke so raster is centered.

3.2.4 VIDEO CENTERING

Set HORIZ CENT (R138) to point where video is centered on raster.

3.2.5 BRIGHTNESS (WITH EXTERNAL CONTROL)

a. Set external control for maximum brightness.
b. Set BRT (R165) for dim raster.

3.2.6 BRIGHTNESS (WITHOUT EXTERNAL CONTROL)

Set BRT (R165) to point where raster is just extinquished.

3.2.7 CONTRAST (WITH INTERNAL CONTROL)

a. Supply window signal to unit.
b. Set CTRS (R121) for desired light level.

3.2.8 CONTRAST (WITH INTERNAL CONTROL)

a. Supply window signal to unit.
b. Set external control (500 ohm, 1/4 W potentiometer) for desired light level.

3.2.9 VERTICAL LINEARITY

Set [VERT LIN] (R110) for equal character height on top and bottom rows.

3.2.10 HEIGHT

Set [HEIGHT] (R107) for desired height.

3.2.11 HORIZONTAL LINEARITY/WIDTH

a. Adjust [LINEARITY] (L103) for maximum width.
b. Adjust [LINEARITY] for best overall linearity. Maintain as much width as possible.
c. Set [WIDTH] (L104) for desired width. (Adjustment slug must not protrude from rear.)
d. Repeat step b for final [LINEARITY] setting.

3.2.12 GEOMETRIC CORRECTION

Using RTV or equivalent, glue pincushion magnets on yoke as required.

3.2.13 FOCUS

a. Insure light level meets requirements of 3.2.7 or 3.2.8.
b. Set [FOCUS] (R157) for best compromise between best corner focus and best center focus.

SECTION 4

THEORY OF OPERATION

Theory of operation is keyed to Functional Blocked Schematic, Figure 4-1.

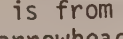
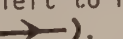
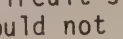
4.1 FUNCTIONAL BLOCKED SCHEMATIC

Schematic is blocked into major and minor functions by gray shading. Major functions are identified in the upper, left-hand corner of their block:

VERTICAL DRIVE
HORIZONTAL DRIVE
FLYBACK TRANSFORMER
GRID BIAS CIRCUIT
VIDEO CASCODE AMPLIFIER
ARC SUPPRESSION
CATHODE RAY TUBE

Minor functions are elements of major functions and are numbered coded in the upper, left-hand corner. Just beside these circled number codes are the abbreviated names for the blocks. Example: FIL for filter, IC for integrated circuit, etc. The dash numbers are assigned consecutively to identify different filters, integrated circuits, etc. The theory is arranged to follow the sequence of the number codes and the full names of the abbreviations are given.

Schematic has been drawn, where practical, to following standards:

a. Major signal (data) flow is from left to right and is indicated by heavy lines with single arrowheads ().
b. Minor signal flow (also left to right) is indicated by standard lines with single arrowheads ().
c. Feedback signal flow is from right to left and is indicated by standard lines with double arrowheads ( ).
d. Voltage reference signals are indicated by bullet-shaped arrowheads ( ).
e. Hollow arrowheads () indicate fault signals. For example, an overvoltage protection circuit signal would have a hollow arrowhead since the signal would not occur unless an overvoltage (fault) condition existed.
f. Input voltages are at top and grounds are at bottom of blocks.
g. Signals enter at left and leave at right of blocks.
h. Grounds are indicated by hollow triangles containing numbers. Numbers used correspond to jack pin numbers where grounds terminate.
   Examples:
   1 - ground terminating at J101, pin 7
   10 - ground terminating at J101, pin 10.
   The exception to this is Arc Ground (J105, Pins 1,2) indicated by symbol.
i. Test points are located throughout schematic and are indicated by hollow triangles containing TP and identifying numbers. Below the schematic are test point location guides. These are grouped by function and located so schematic and location guide triangles point at each other as though connected by a straight vertical line.

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j. Some components change value depending on design parameters. These components have their reference designations enclosed in bullet-shaped boxes (R113) . Tabulated value changes are located left and right of the schematic. Each bullet-shaped box points along an imaginary straight horizontal line to its own respective values.

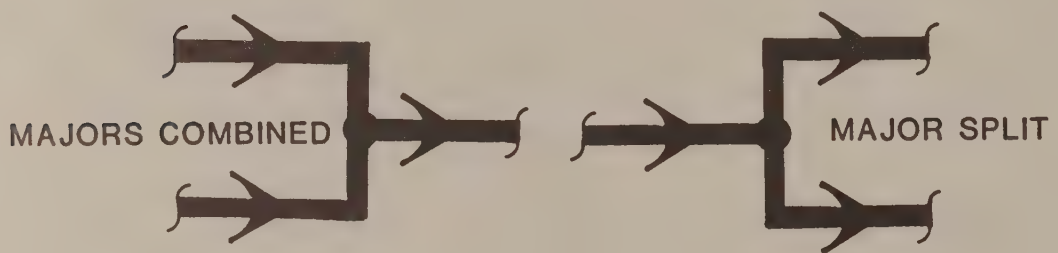
k. Information such as voltage levels and warnings are enclosed in flag-shaped boxes which point to area or item concerned -150V .

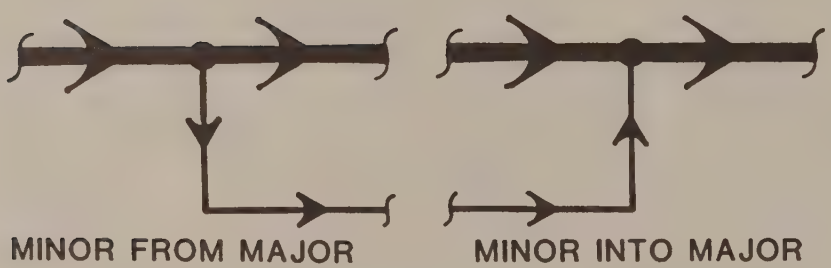
l. Warnings and adjustments are highlighted with white backgrounds.

m. Signal flow direction has been given priority over hardware outlines. Therefore hardware is shaped to accommodate requirements that signal flow be shown left to right.

n. Lines do not cross unless connected. Those which would ordinarily cross without connection are interrupted by broken line symbols.

o. Power and signal flow lines are connected to show their order of importance:





p. Options are enclosed in dashed-line boxes. They are determined by use of Data Display.

q. Adjustments are indicated by a white background (as noted in l) and they are contained in shadowed boxes FOCUS . The notation inside the box appears the same as shown on the printed circuit board.

PWA BC/BCX-200/300

VERTICAL DRIVE

WARNING
HIGH
VOLTAGES

FLYBACK
TRANSFORMER

GRID BIAS CIRCUITS

U101
(TDA 1170S)
FOR BLOCK
DIAGRAM
SEE FIGURE
4-2

U102
(MC1391
OR 1394)
FOR
BLOCK
DIAGRAM
SEE
FIGURE
4-3

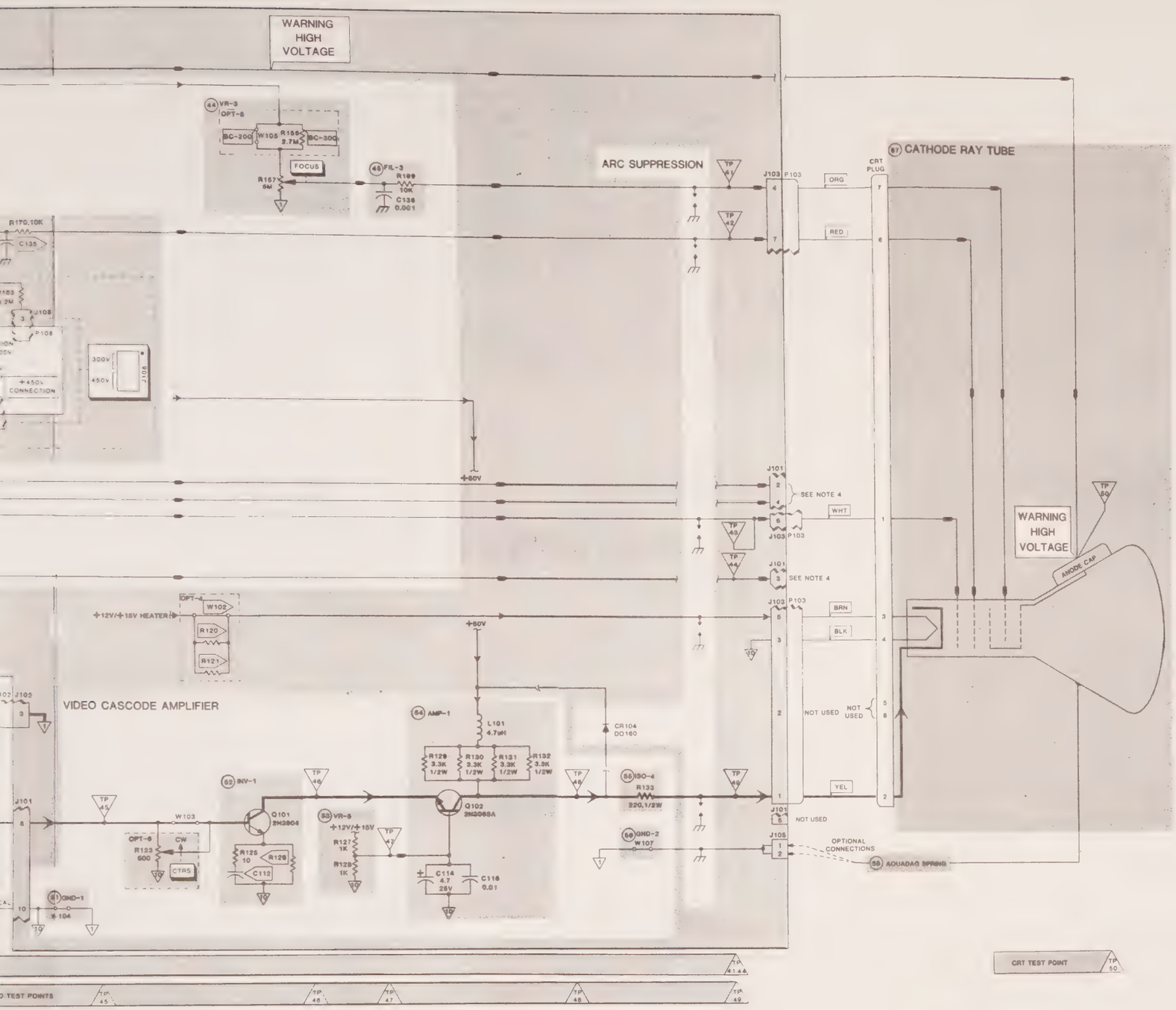
HORIZONTAL DRIVE

VERTICAL DRIVE TEST POINTS

POWER SUPPLY TEST POINT

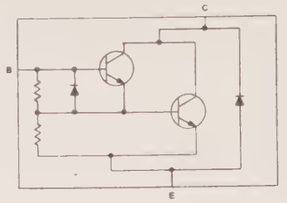
HORIZONTAL DRIVE TEST POINTS

GRID BIAS CIRCUITS TEST POINTS

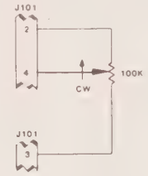


NOTES UNLESS OTHERWISE SPECIFIED.

1. FIXED RESISTOR VALUES ARE OHMS, 5% TOLERANCE, 1/4 WATT
2. CAPACITOR VALUES ARE MICROFARADS
3. Q109 SCHEMATIC



4. J101-2, 4, 3 ARE FOR OPTIONAL EXTERNAL BRIGHTNESS CONTROL. CONNECT AS SHOWN:



5. J101 IS A BOARD-EDGE CONNECTOR. J106 (NOT SHOWN) IS AN OPTIONAL STANDARD CONNECTOR. THEY ARE FUNCTIONALLY IDENTICAL PIN FOR PIN
6. PROTECTIVE ARC GAPS ARE AN INTEGRAL PART OF PRINTED CIRCUIT BOARD.
7. Q108 REQUIRES HEAT SINK.
8. MAJOR SIGNAL FLOW . . . . MINOR SIGNAL FLOW . . . . . FAULT SIGNAL
   FEEDBACK SIGNAL FLOW VOLTAGE REFERENCE

MODEL OPTIONS	BC-200	BC-300
CR110	D0403	D0488
C135	0.01, 1kV	0.005, 2kV

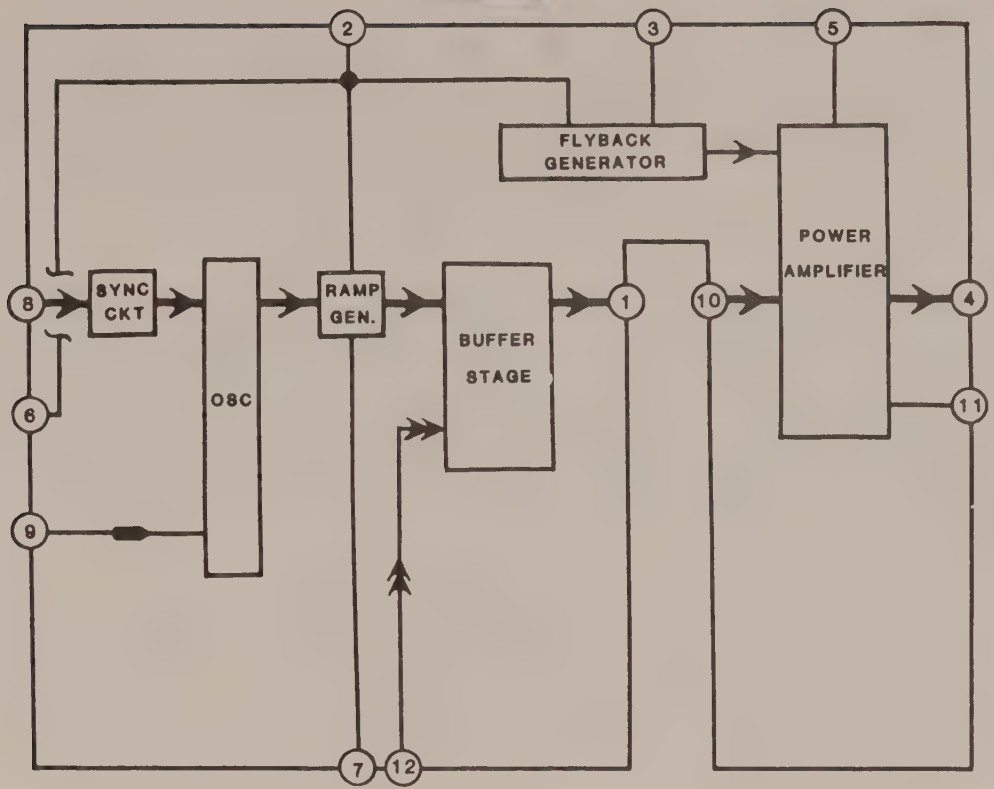
CRT HEATER OPTIONS	150mA/12.6V		140mA/11.0V		75mA/12.0V	
	+12V	+15V	+12V	+15V	+12V	+15V
W102	USED	NOT USED	NOT USED	NOT USED	USED	NOT USED
R120	NOT USED	NOT USED	NOT USED	62, 1/2W	NOT USED	NOT USED
R121	NOT USED	18, 1/2W	6.8, 1/4W	62, 1/2W	NOT USED	33, 1/4W

POWER SUPPLY OPTIONS	+12V	+15V
R148	120	270
VR101	ZO405	ZO517

COMPONENT	LOCATED IN BLOCK	COMPONENT	LOCATED IN BLOCK	COMPONENT	LOCATED IN BLOCK
C101	2	IC-1	8	R136	22
2	6	IC-2	29	37	23
3	6			38	23
4	4			39	23
5	7	L1-A	14	R140	25
6	9	L1-B	41	41	24
7	9	L101	54	42	26
8	11	2	18	43	27
9	12	3	39	44	26
C110	13	4	39	45	28
11	15			46	28
12	52			47	28
13	1	Q101	52	48	34
14	54	2	54	49	27
15	54	3	22	R150	27
16	47	4	24	51	30
17	18	5	30	52	30
18	18	6	31	53	30
19	20	7	31	54	30
C120	NOT USED	8	33	55	4
21	23			56	4
22	26			57	4
23	28	R101	2	58	3
24	32	2	3	59	4
25	35	3	6	R160	4
26	34	4	3	61	4
27	34	5	4	62	NOT
28	38	6	4	63	4
29	39	7	5	64	
C130	43	8	5	65	
31	43	9	9	66	
32	48	R110	9	67	
33	NOT USED	11	9	68	
34	39	12	10	69	
35	46	13	17	R170	
36	45	14	13	71	
37	40	15	12	72	
38	50	16	11		
		17	13		
		18	16	T101	FLYB
CR101	NOT USED	19	NOT USED		
2	NOT USED	R120	OPT-4		
3	7	21	OPT-4	VR101	
4	ARC SUPPRESSION	22	NOT USED	2	
5	21	23	OPT-6		
6	26	24	NOT USED		
7	32	25	52		
8	35	26	52		
9	37	27	53		
CR110	43	28	53		
11	47	29	54		
12	48	R130	54		
		31	54		
		32	54		
F1	1	33	55		
		34	19		
		35	20		

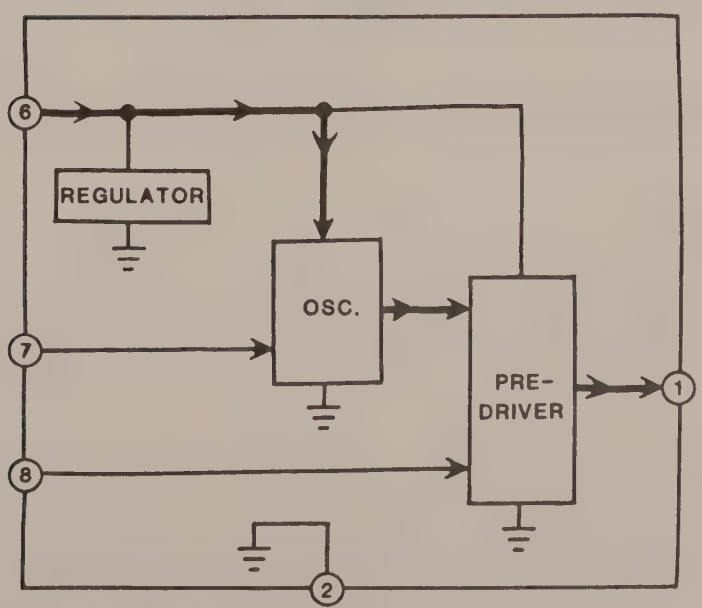
NCTIONAL BLOCKED SCHEMATIC

Figure 4-1



U101 (IC-1) FUNCTIONAL BLOCK DIAGRAM

FIGURE 4-2



U102 (IC-2) FUNCTIONAL BLOCK DIAGRAM

FIGURE 4-3

4.2 CIRCUIT THEORY

Refer to Figure 4-1, BC/BCX-200/300 FUNCTIONAL BLOCKED SCHEMATIC.

Input voltage, depending on model, is routed either through J101-7 or J104-2, 5 to:

(1) PS-1 (POWER SUPPLY): Provides voltage for general circuit use and for CRT heater. Note that CRT heater is not fused.

VERTICAL DRIVE: Single, high-performance integrated circuit provides a linear current ramp (sawtooth) for vertical deflection. One cycle involves:

Positive or negative sync pulse is routed through CPL-1 and VD-1 to IC-1. Inside IC-1 (see Figure 4-2) the SYNC CKT sets the OSC so the RAMP GEN initiates a sawtooth. BUFFER STAGE couples this to pin 1, through ISO-1, into pin 10 where is is amplified by POWER AMPLIFIER. Output at pin 4 is coupled to VERT COIL. Deflection current, after passing through VERT COIL, goes through CS-1 and FB-4 to ground. Four feedbacks provide current ramp shaping and stabilization.

a. FB-1: provides current ramp shaping.
b. FB-2: provides high frequency stabilization.
c. FB-3: provides deflection voltage sensing.
d. FB-4: provides deflection current sensing.

When the RAMP GEN in IC-1 ends the sawtooth, FLYBACK GENERATOR and VDR-1 double the deflection voltage for faster retrace.

Inputs to IC-1:

(2) CPL-1 (COUPLER): Differentiates the sync pulse.
(3) VD-1 (VOLTAGE DIVIDER): Adjusts sync signal level.
(4) VR-1 (VOLTAGE REFERENCE): VERT HOLD adjusts R106, R105-C104 time constant. Setting determines free-run oscillation frequency of IC-1.
(5) CR-1 (CURRENT REGULATOR): HEIGHT adjusts current from IC-1, pin 7 to ground. Amount of current flow determines p-p current through vertical deflection coil.
(6) DEC-1 (DECOUPLER): Decouples voltage to IC-1 and VDR-1.
(7) VDR-1 (VOLTAGE DOUBLER): Uses FLYBACK GENERATOR of IC-1 to double voltage for faster vertical retrace.

Using these inputs:

(8) IC-1 (INTEGRATED CIRCUIT): Accepts positive or negative sync signals and ignores further inputs during first portion (approximately 85%) of sawtooth output. In the absence of sync signals, IC-1 is a free-running oscillator with frequency slightly slower than sync signal frequency.

IC-1 outputs:

(9) FB-1 (FEEDBACK): Provides feedback for S-shaping the deflection coil current ramp. VERT LIN adjusts C-shaping.
(10) ISO-1 (ISOLATOR): Couples ramp signal to output stage of IC-1.
(11) FB-2 (FEEDBACK): High frequency stabilization for IC-1.
(12) FIL-1 (FILTER): Helps prevent high frequency oscillation.

(13) FB-3 (FEEDBACK): Provides filtering and isolation for vertical coil voltage feedback.
(14) VERT COIL: Provides vertical electron beam deflection.
(15) CS-1 (CURRENT SHAPER): S-shaping capacitor also blocks dc current from vertical deflection coil to ground.
(16) FB-4 (FEEDBACK): Provides sampling of vertical deflection current.
(17) ISO-2 (ISOLATOR): Current sensing feedback path.

HORIZONTAL DRIVE: Positive sync pulse is coupled through ISO-3 and differentiated by DIF-1. CPL-2 passes the positive spike to the one-shot (blocks 22 through 25). SW-1 is turned on. C121 in RC-1 couples the negative SW-1 output and turns SW-2 off. The positive output of SW-2 is fed back by FB-5 and holds SW-1 on. R138, R139-C121 time constant of RC-1 determines the pulse width of SW-2 output. When SW-2 output goes negative, CPL-3 couples this signal to IC-2 which resets its internal oscillator. When the oscillator times out, IC-2 output goes negative. This negative signal is current amplified (no phase inversion) by SW-3, coupled through CPL-4 and turns SW-4 off, initiating flyback.

(18) DEC-2 (DECOUPLER): Provides voltage isolation for horizontal circuits.
(19) ISO-3 (ISOLATOR): Isolation resistor.
(20) DIF-1 (DIFFERENTIATOR): Differentiates sync pulse.
(21) CPL-2 (COUPLER): Passes positive sync pulse spikes.

Note: Functional Blocks (22) through (25) comprise a monostable multivibrator (one-shot). This one-shot provides the first of two time delays in the Horizontal Drive section.

(22) SW-1 (SWITCH): Turned on by positive sync pulse spike.
(23) RC-1 (RC TIMING CIRCUIT): HORIZ CENT adjusts pulse width output of SW-2. Pulse width determines video display position within the raster. SW-1 grounds input to RC-1 causing RC-1 output to go negative. RC time constant (R138-R139, C121) determines when SW-2 switches back on.
(24) SW-2 (SWITCH): Turned off by negative output of RC-1. Turns on when RC-1 times out.
(25) FB-5 (FEEDBACK): Couples positive SW-2 output to SW-1, keeping SW-1 on until SW-2 turns on again.

Note: Entire one-shot cycle is repeated for each positive sync pulse.

(26) CPL-3 (COUPLER): Couples output of one-shot to IC-2.

Note: Positive, leading edge of one-shot output does nothing; it is the negative trailing edge coupled by CR106 and C122 to IC-2 which triggers IC-2.

Note: Functional Blocks (27)through (29) comprise an oscillator with a free-run frequency slightly slower than Horizontal Drive sync frequency. This oscillator provides the second of two time delays in the Horizontal Drive section.

(27) VD-2 (VOLTAGE DIVIDER): Provides dc voltages for pins 6 and 8 of IC-2. Pin 8 voltage determines duty cycle of pin 1 output.
(28) VR-2 (VOLTAGE REFERENCE): HORIZ HOLD adjusts free-run frequency of IC-2 oscillator; provides an RC-controlled reference voltage.
(29) IC-2 (INTEGRATED CIRCUIT): Connected as an oscillator controlled by VR-2 and VR-3. Pin 6 is used in a dual manner:
a. It is the normal dc input voltage pin.

b. It is used for synchronizing the oscillator via negative signals from CPL-3. (See Figure 4-3 for block diagram.)

(30) OVP-1 (OVERVOLTAGE PROTECTION): For overvoltage conditions, provides shutdown and prevents excessive x-radiation. Overvoltage causes VR101 to conduct and turn Q105 on. Q105 grounds SW-3 input.

(31) SW-3 (SWITCH): Q106 provides current drive for SW-2. Q107 provides negative discharge path for C124 in CPL-4.

(32) CPL-4 (COUPLER): Provides ac signal coupling.

(33) SW-4 (SWITCH): Darlington amplifier used as current switch. Flyback is initiated when switch turned off.

(34) DEC-3 (DECOUPLER): Isolates other circuits from PRI-1 current surges.

(35) VDR-2 (VOLTAGE DOUBLER): Together with autotransformer action of PRI-1, boosts voltage at pin 4 (or pin 3) of PRI-1. CR108 conducts during first portion of time period D, as discussed under HORIZONTAL DEFLECTION.

(36) PRI-1 (PRIMARY): In addition to providing normal function of a primary winding, PRI-1 is wound as an autotransformer. This design provides a means for boosting voltage used for horizontal deflection.

HORIZONTAL DEFLECTION: Provides linear current ramp (sawtooth) and flyback voltage for horizontal deflection coil. One cycle involves:

Notes:
1. Electron beam movement directions are for viewer observing face of CRT. (Conventional scan direction.)
2. Deflection coil current polarity assumes conventional current flow: positive to negative.
3. Beam movement is smooth and continuous throughout cycle.
4. Total flyback time in B and C is approximately 7.5 microseconds.
5. All numerical values are approximate.

A. DEFLECTION FROM CENTER SCREEN TO EXTREME RIGHT: Left side of C129 (in CS-2) is charged to somewhere between +17V and +25V depending on model and line rate (no beam movement). Charge path was from pin 4 (or pin 3) of PRI-1 through the primary coil. (Note that the capacitance of C129 is large enough so that throughout the cycle the voltage across it remains essentially the same.) When SW-4 switches on, the left side of C129 is clamped near zero, forcing the right side to drop to -17V to -25V. Current ($-I_y$) flows from ground, through HORIZ COIL, through L104 and L103 into C129. The electron beam is moved to the extreme right at which time $-I_y$=4 amps.

B. FLYBACK FROM EXTREME RIGHT TO CENTER SCREEN: SW-4 shuts off. Rapidly collapsing magnetic fields around HORIZ COIL, L104, L103 and T101 induce a voltage which charges C128 (in TUN-1) to +180 volts as $-I_y$ drops from 4 to zero amps. (This is the first half of the flyback pulse.) Beam is moved rapidly to center.

C. FLYBACK FROM CENTER SCREEN TO EXTREME LEFT: With C128 at +180 volts, the right side of C129 is at +155V to +163V. This forces current ($+I_y$) through L103 and L104, through HORIZ COIL to ground. Beam is moved rapidly to extreme left at which time $+I_y$=4 amps. While this is occurring, C129 is also being discharged through PRI-1 into C125 of VB-1. This is the second half of the flyback pulse used by T101 in producing high voltages for the CRT.

D. DEFLECTION FROM EXTREME LEFT TO CENTER SCREEN: Collapsing magnetic fields induce a negative voltage across C128, forward biasing CR109 (in DA-1). This clamps HORIZ COIL to the 17 to 25 volt charge held by C129. +Iy drops from 4 to zero amps. Beam is deflected toward center. Just before beam reaches center, SW-4 turns on and cycle A,B,C,D, repeats.

(37) DA-1 (DAMPER): CR109 is damping diode which prevents flyback pulse oscillation by providing a path for deflection coil current to continue circulation.
(38) TUN-1 (TUNER): Flyback tuning capacitor.
(39) CS-2 (CURRENT SHAPER): LINEARITY and WIDTH provide means for controlling shape of deflection coil current ramp. C129 provides S-shaping.
(40) FIL-2 (FILTER): High-pass filter.
(41) HORIZ COIL: Provides horizontal electron beam deflection.
(42) SEC-1 (SECONDARY): Provides power for circuit controlling CRT grid functions and for the VIDEO CASCODE AMPLIFIER. Provides CRT anode voltage via half-wave rectification by diode which is part of T101.

GRID BIAS CIRCUITS: Provide bias voltages for brightness, focus and beam acceleration. Also provides voltage for AMP-1.

(43) PS-2 (POWER SUPPLY): For focus and acceleration voltages. Transformed flyback pulse is rectified and capacitively stored.
(44) VR-3 (VOLTAGE REFERENCE): Provides FOCUS adjustment.
(45) FIL-3 (FILTER): C136 filters VR-3 output. R169 provides arc gap isolation.
(46) FIL-4 (FILTER): Filters acceleration grid voltage. R162 provides arc gap isolation. (See OPT-3.)
(47) PS-3 (POWER SUPPLY): Provides +50 volts used for brightness control and for VIDEO CASCODE AMPLIFIER. Rectifies and capacitively stores transformed flyback pulses.
(48) PS-4 (POWER SUPPLY): Provides -150 volts used for brightness control. Rectifies and capacitively stores transformed flyback pulses.
(49) VR-4 (VOLTAGE REFERENCE): BRT controls grid one cutoff voltage. Adjusted to just extinquish raster at cutoff. (See OPT-3.)
(50) FIL-3 (FILTER): Filters brightness grid voltage. R172 provides arc gap isolation.
(51) GND-1 (GROUND): W104 ties Video/Vert GND (J101-10) to Horizontal Ground (J101-1). Note that these two grounds are identified throughout the schematic by their pin numbers enclosed in a triangle.

VIDEO CASCODE AMPLIFIER: 20MHz amplifier with 20 nanosecond rise and fall times.

(52) INV-1 (INVERTER): Provides current gain. R125, C112 peak the high frequency response. R126 determines overall gain.
(53) VR-5 (VOLTAGE REFERENCE): Supplies AMP-1 base with +6 volts.
(54) AMP-1 (AMPLIFIER): Standard common base configuration. L101 is peaking inductor. C114, C115 filter base reference voltage.
(55) ISO-4 (ISOLATION): Cathode isolation resistor.
(56) GND-2 (GROUND): W107 ties horizontal ground to arc ground.
(57) CATHODE RAY TUBE: Conventional electromagnetic deflection CRT.
(58) AQUADAG SPRING: Provides ground connection for CRT.

OPT-1 (OPTION): Used for models with ac power input (120 or 220/240 vac). J104 is supplied with dc voltage input from built-in switching power supply.

OPT-2 (OPTION): Provides connections for low or high line rates. Selection can be made in one of two ways:
1. Jumper selection on board
2. P102 wiring connection

OPT-3 (OPTION): Provides connections for selecting various G2 voltages to match different CRT requirements.

OPT-4 (OPTION): Provides fixed resistance(s) for special heater requirements.

OPT-5 (OPTION): Provides selection for BC-200/300 requirements.

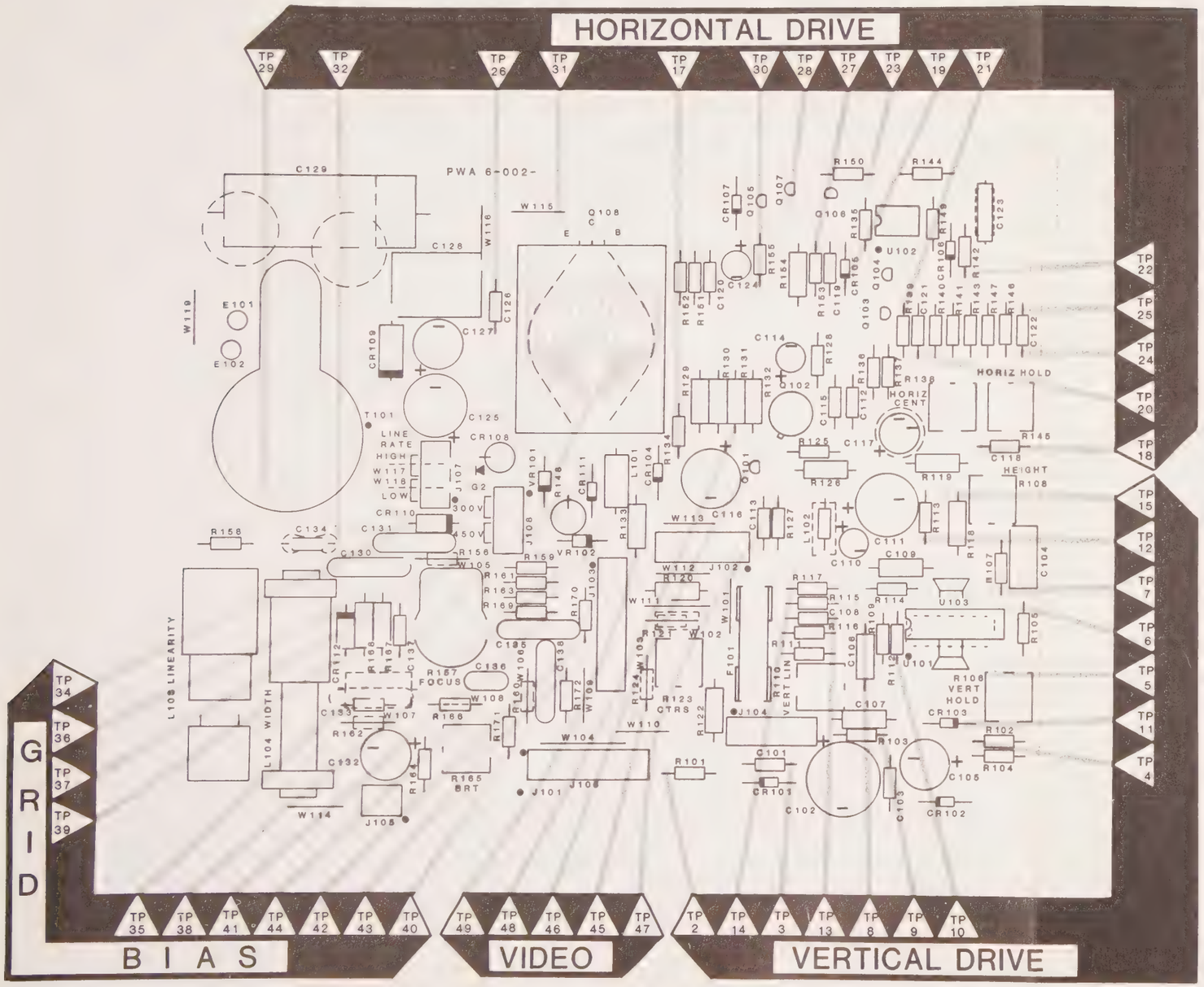
OPT-6 (OPTION): CTRS provides internal contrast control.

SECTION 5

TROUBLESHOOTING

Following aids are used for isolating faulty components:

a. Functional Blocked Schematic, Figure 4-1
b. Test Point Location, Figure 5-1
c. Test Points Data, Figure 5-2

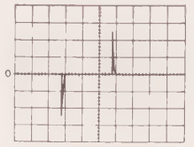


TEST POINTS LOCATION
Figure 5-1

TP 1 — +12 VOLTS OR +15 VOLTS

TP 2 — AMPLITUDE: 4.0±1.5 VOLTS, SYNC POSITIVE OR NEGATIVE
FREQUENCY: 47-82 Hz
PULSE WIDTH: 75 uSEC TO ≤ VERTICAL BLANKING TIME MINUS SYNC DELAY
RISE/FALL TIMES: 100nSEC MAXIMUM
BLANKING TIME: 850 uSEC MINIMUM

TP 3

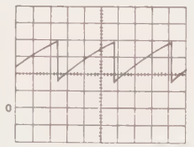


PROBE: X10
VERT: 1.0 V/DIV
HORIZ 0.2 mSEC/DIV

TP 4 — SAME AS TP3

TP 5 — +6.6 VOLTS

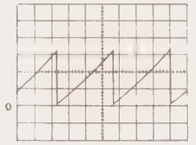
TP 6



PROBE: X10
VERT: 1 V/DIV
HORIZ: 5 mSEC/DIV

TP 7 — +6.7 VOLTS

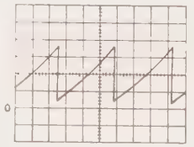
TP 8



PROBE: X10
VERT: 2V/DIV
HORIZ: 5 mSEC/DIV
NOTE: FREQUENCY RANGE IS 47-82 Hz

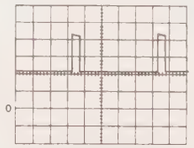
TP 9 — +11.9 VOLTS OR +14.9 VOLTS

TP 10



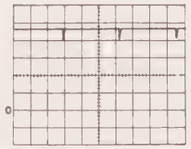
PROBE: X10
VERT: 2 V/DIV
HORIZ: 5 mSEC/DIV

TP 11



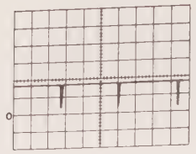
PROBE: X10
VERT: 5 V/DIV
HORIZ: 10 mSEC/DIV

TP 12



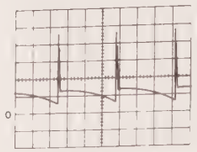
PROBE: X10
VERT: 0.5 V/DIV
HORIZ: 5 mSEC/DIV

TP 13

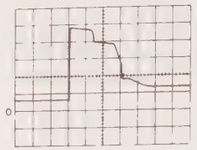


PROBE: X10
VERT: 0.5 V/DIV
HORIZ: 5 mSEC/DIV

TP 14

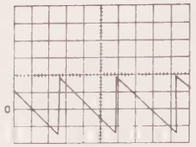


PROBE: X10
VERT: 5 V/DIV
HORIZ: 5mSEC/DIV



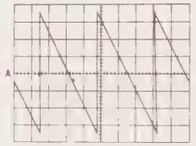
PROBE: X10
VERT 5 V/DIV
HORIZ: 0.1 mSEC/DIV

TP 15



PROBE: X10
VERT: 0.2 V/DIV
HORIZ: 5 mSEC/DIV
NOTE: SAME AS VERTICAL YOKE CURRENT

TP 16

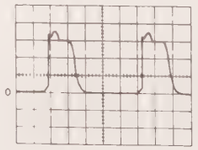


CURRENT PROBE: X10
VERT: 0.1 AMP/DIV
HORIZ: 5 mSEC/DIV

TP 17 — AMPLITUDE: 4.0±1.5 VOLTS, SYNC POSITIVE
FREQUENCY: LO-LINE RATE...15,750± 500 Hz
HI-LINE RATE...18,400±1000 Hz
PULSE WIDTH: 2.5-40 uSEC
RISE/FALL TIMES: 50 nSEC MAXIMUM
BLANKING TIME: 10 uSEC MINIMUM

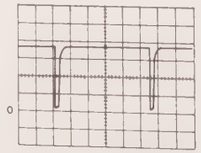
TP 18 — +12 VOLTS OR +15 VOLTS

TP 19



PROBE: X10
VERT: 0.2 V/DIV
HORIZ: 10 uSEC/DIV

TP 20



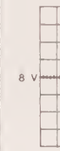
PROBE: X10
VERT: 2 V/DIV
HORIZ: 10 uSEC/DIV

TP 21

TP 22

TP 23

TP 24

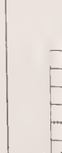


TP 25

TP 26

TP 27

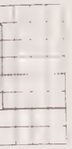
TP 28



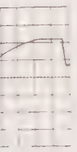
TP 29

TP 30

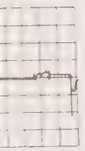
PROBE: X10
VERT: 2 V/DIV
HORIZ: 10 uSEC/DIV



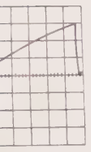
PROBE: X10
VERT: 2 V/DIV
HORIZ: 10 uSEC/DIV
NOTE: HORIZ CENT
ADJUSTMENT CAN VARY
PULSE WIDTH 2-30 uSEC



PROBE: X10
VERT: 1 V/DIV
HORIZ: 10 uSEC/DIV



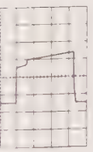
PROBE: X10
VERT: 0.5 V/DIV
HORIZ: 10 uSEC/DIV
NOTE: OSCILLOSCOPE IS
AC COUPLED



PROBE: X10
VERT: 1 V/DIV
HORIZ: 10 uSEC/DIV

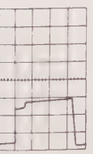
+15 VOLTS

PROBE: X10
VERT: 2 V/DIV
HORIZ: 10 uSEC/DIV



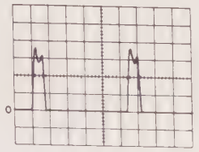
PROBE: X10
VERT: 2 V/DIV
HORIZ: 10 uSEC/DIV

MINAL



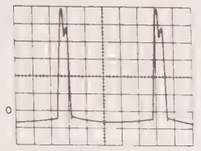
PROBE: X10
VERT: 2 V/DIV
HORIZ: 10 uSEC/DIV

TP 31



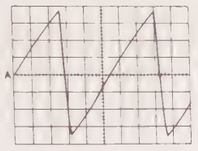
PROBE: X10
VERT: 50 V/DIV
HORIZ: 10 uSEC/DIV

TP 32



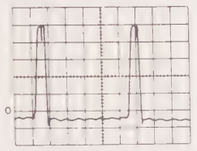
PROBE: X10
VERT: 20V/DIV
HORIZ: 10 uSEC/DIV

TP 33



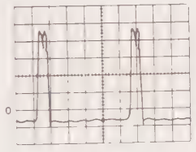
CURRENT PROBE: X10
VERT: 1 AMP/DIV
HORIZ: 10 uSEC/DIV

TP 34



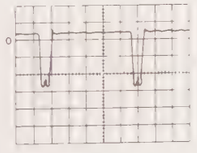
PROBE: X100
VERT: 100 V/DIV
HORIZ: 10 uSEC/DIV

TP 35



PROBE: X10
VERT: 10 V/DIV
HORIZ: 10 uSEC/DIV

TP 36



PROBE: X10
VERT: 50 V/DIV
HORIZ: 10 uSEC/DIV

TP 37 +500 VOLTS NOMINAL

TP 38 +50 VOLTS NOMINAL

39 -150 VOLTS NOMINAL

TP 40 MIN: -75 VOLTS...MAX: +15 VOLTS

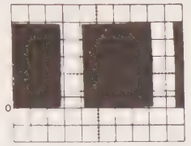
TP 41 MIN: ZERO VOLTS...MAX: +500 VOLTS

TP 42 +500 VOLTS NOMINAL

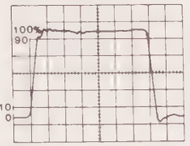
TP 43 MIN: -75 VOLTS...MAX: +15 VOLTS

TP 44 -75 VOLTS NOMINAL

TP 45

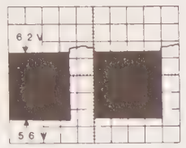


PROBE: X10
VERT: 0.5 V/DIV
HORIZ: 10 uSEC/DIV
NOTE: 2.5 VOLT p-p
CROSSHATCH
SIGNAL AT TP45



PROBE: X100
VERT: UNCALIBRATED
HORIZ: 20 nSEC/DIV

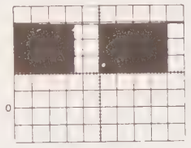
TP 46



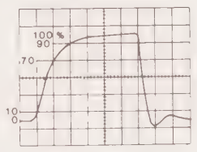
PROBE: X10
VERT: 0.2 V/DIV
HORIZ: 10 uSEC/DIV
NOTE: AC COUPLING USED...
APPROXIMATE DC LEVELS
NOTED

TP 47 +6 VOLTS OR +7.5 VOLTS

TP 48



PROBE: X100
VERT: 10 V/DIV
HORIZ: 10 uSEC/DIV



PROBE: X100
VERT: UNCALIBRATED
HORIZ: 20 nSEC/DIV

TP 49 SAME AS TP48

TP 50 +13,000±500 VOLTS

NOTE: USE 1000:1 PROBE AT ANODE CAP

TEST POINTS DATA
Figure 5-2

SECTION 6

PARTS REPLACEMENT

6.1 ORDERING PARTS

Order spare and replacement parts from nearest sales office:

CALIFORNIA:	Campbell	(408)374-4120
	Upland	(714)985-7110
ILLINOIS:	Downers Grove	(312)960-4434
NEW HAMPSHIRE:	Salem	(603)893-3050
NEW JERSEY:	Ocean	(201)922-2800
UNITED KINGDOM:	Newbury, Berkshire	(0635)30770-44
WEST GERMANY:	Offenbach	(0611)817041-49

The following parts information is needed:

a. Model:.....Example: BCX-200
b. Schematic Reference Symbol:....Example: R101
c. Description:.....Example: 1K, 1/4W, 5% Resistor
d. Part Number:.....Example: 1-011-2553

6.2 PARTS LIST

REF SYM	DESCRIPTION	PART NUMBER
B100	PWB'S	1-029-0543 1-060-0100 1-060-0102
C101	.001µF-50-20	1-012-2452
C102	1000µF-25	1-012-2341
C103	.1µF-50-20	1-012-2455
C104	.15µF-100-5	1-012-2359
C105	100µF-25	1-012-2200
C106	.1µF-50-10	1-012-2505
C107	.1µF-50-10	1-012-2505
C108	33pF-50-20	1-012-2450
C109	.1µF-50-10	1-012-2505
C110	4.7µF-25	1-012-2448
C111	1000µF-10	1-012-2442

REF SYM	DESCRIPTION	PART NUMBER
C112	OPTIONS:	
	Standard Model:	390pF-50-20
	High Performance Model:	220pF-50-5
C113		.1μF-50-20
C114		4.7μF-25
C115		.01μF-50-20
C116		47μF-100
C117		22μF-25
C118		.01μF-50-20
C119		560pF-25-10
C120		NOT USED
C121		560pF-50-20
C122		.001μF-50-20
C123		5600pF-100-5
C124		4.7μF-25
C125	OPTIONS:	
	Standard Model:	1000μF-16
	High Performance Model:	470μF-35-20
C126		.01μF-50-20
C127		220μF-25
C128		.027μF-400-5
C129	OPTIONS:	
	Standard Model:	15μF-50
	High Performance Model:	10μF-25
C130		.01μF-1000-20
C131		.01μF-1000-20
C132		3.3μF-250
C133		NOT USED
C134		.001μF-50-20
C135	OPTIONS:	
	BC-200:	.01-1000-20
	BC-300:	.005-2000-20
C136		.001μF-1000-20
C137		.01μF-50-20
C138		.01μF-1000-20
CR101		NOT USED
CR102		NOT USED
CR103		D0410
CR104		D0160
CR105		D0410
CR106		D0410
CR107		D0410
CR108		D0484
CR109		D0458
CR110	OPTIONS:	
	BC-200:	D0403
	BC-300:	D0448
CR111		D0160
CR112		D0403

REF SYM	DESCRIPTION	PART NUMBER
F101	3A	1-028-0267
H101	FUSE CLIP	2-050-0210
H102	FUSE CLIP	2-050-0210
L1	YOKE	1-023-0262A
L101	4.7µH	1-016-0395
L102	100µH	1-016-0409
L103	LINEARITY	1-016-0372
L104	WIDTH	1-016-0390
Q101	2N3904	1-015-1144
Q102	2N3053A	1-015-1205
Q103	2N3904	1-015-1144
Q104	2N3904	1-015-1144
Q105	MPS-A16	1-015-1193
Q106	2N3904	1-015-1144
Q107	2N3905	1-015-1133
Q108	TRANS ASSY	6-003-0826
R101	1K-1/4-5	1-011-2553
R102	2.2K-1/4-5	1-011-2580
R103	10-1/4-5	1-011-2551
R104	4.7K-1/4-5	1-011-2613
R105	100K-1/4-5	1-011-2555
R106	VAR, 250K-1/4-20	1-011-5759
R107	180K-1/4-5	1-011-2575
R108	VAR, 250K-1/4-20	1-011-5759
R109	1M-1/4-5	1-011-2556
R110	VAR, 100K-1/4-20	1-011-5758
R111	62K-1/4-5	1-011-2625
R112	620K-1/4-5	1-011-2626
R113	68K-1/4-5	1-011-2630
R114	56K-1/4-5	1-011-2621
R115	3.3-1/4-5	1-011-2702
R116	82K-1/4-5	1-011-2638
R117	56K-1/4-5	1-011-2621
R118	1-1/2-5	1-011-2704
R119	NOT USED	
R120	OPTIONS:	
	A NOT USED	
	B NOT USED	
	C NOT USED	
	D 62-1/2-5	1-011-2645
	E NOT USED	
	F NOT USED	

WHERE:
A = 150ma/+12.6V CRT Filament with +12V Supply
B = 150ma/+12.6V CRT Filament with +15V Supply
C = 140ma/+11.0V CRT Filament with +12V Supply

REF SYM	DESCRIPTION	PART NUMBER
R120	WHERE (CONT.):	
	D = 140ma/+11.0V CRT Filament with +15V Supply	
	E = 75ma/+12.0V CRT Filament with +12V Supply	
	F = 75ma/+12.0V CRT Filament with +15V Supply	
R121	OPTIONS:	
	A — NOT USED (W102 USED)	
	B — 16-1/2-5	1-011-2227
	C — 6.8-1/4-5	1-011-2736
	D — 62-1/2-5	1-011-2645
	E — NOT USED (W102 USED)	
	F — 33-1/4-5	1-011-2596
	WHERE:	
	A = 150ma/+12.6V CRT Filament with +12V Supply	
	B = 150ma/+12.6V CRT Filament with +15V Supply	
	C = 140ma/+11.0V CRT Filament with +12V Supply	
	D = 140ma/+11.0V CRT Filament with +15V Supply	
	E = 75ma/+12.0V CRT Filament with +12V Supply	
	F = 75ma/+12.0V CRT Filament with +15V Supply	
R122	NOT USED	
R123	VAR, 500-1/4-20	1-011-5755
R124	NOT USED	
R125	10-1/4-5	1-011-2551
R126	OPTIONS:	
	Standard Model: 33-1/2-5	1-011-2234
	High Performance Model: 51-1/2-5	1-011-2239
R127	1K-1/4-20	1-011-2553
R128	1K-1/4-20	1-011-2553
R129	3.3K-1/2-5	1-011-2282
R130	3.3K-1/2-5	1-011-2282
R131	3.3K-1/2-5	1-011-2282
R132	3.3K-1/2-5	1-011-2282
R133	220-1/2-5	1-011-2254
R134	470-1/4-5	1-011-2612
R135	12K-1/4-5	1-011-2562
R136	2.2K-1/4-5	1-011-2580
R137	1.5K-1/4-5	1-011-2568
R138	VAR, 100K-1/4-20	1-011-5758
R139	47K-1/4-5	1-011-2614
R140	68K-1/4-5	1-011-2630
R141	1.8K-1/4-5	1-011-2573
R142	10K-1/4-5	1-011-2554
R143	OPTIONS:	
	A — 120-1/4-5	1-011-2560
	B — 270-1/4-5	1-011-2587
	WHERE:	
	A = Any Model with +12V Supply	
	B = Any Model with +15V Supply	
R144	10K-1/4-5	1-011-2554
R145	VAR, 25K-1/4-20	1-011-5757

REF SYM		DESCRIPTION	PART NUMBER
R146	OPTIONS:		
	Standard Model:	12.1K-1/4-1	1-011-2755
	High Performance Model:	8.2K-1/4-5	1-011-2637
R147		10K-1/4-1	1-011-2754
R148		.47-2-10	1-011-1394
R149		2.4K-1/4-5	1-011-2584
R150	OPTIONS:		
	Standard Model:	2.7K-1/4-5	1-011-2588
	High Performance Model:	2.4K-1/4-5	1-011-2584
R151		10K-1/4-5	1-011-2554
R152		1K-1/4-5	1-011-2553
R153		1K-1/4-5	1-011-2553
R154		81-1/2-5	1-011-2244
R155		33-1/4-5	1-011-2596
R156	OPTIONS:		
	BC-200:	NOT USED (W105 USED)	
	BC-300:	2.7M-1/4-5	1-011-2591
R157		VAR, 5M-1/4-20	1-011-5711
R158		1K-1/4-5	1-011-2553
R159		1.8M-1/4-5	1-011-2726
R160		20K-1/4-5	1-011-2578
R161		2.7M-1/4-5	1-011-2591
R162		NOT USED	
R163		8.2M-1/4-5	1-011-2640
R164		100K-1/4-5	1-011-2555
R165		VAR, 250K-1/4-20	1-011-5759
R166		47K-1/4-5	1-011-2614
R167		10K-1/2-5	1-011-2294
R168		10K-1/2-5	1-011-2294
R169		10K-1/4-5	1-011-2554
R170		10K-1/4-5	1-011-2554
R171		220K-1/4-5	1-011-2582
R172		10K-1/4-5	1-011-2554
T101	OPTIONS:		
	A*	FLYBACK TRANSFORMER	1-017-5470
	B*	FLYBACK TRANSFORMER	1-017-5479
	C*	FLYBACK TRANSFORMER	1-017-5474
	D*	FLYBACK TRANSFORMER	1-017-5480
	E*	FLYBACK TRANSFORMER	1-017-5484
	F*	FLYBACK TRANSFORMER	1-017-5494
	G*	FLYBACK TRANSFORMER	1-017-5485
	H*	FLYBACK TRANSFORMER	1-017-5495

WHERE:
A = Standard BC/BCX-200 with +12V Supply
B = Standard BC/BCX-300 with +12V Supply
C = Standard BC/BCX-200 with +15V Supply
D = Standard BC/BCX-300 with +15V Supply
E = High Performance BC/BCX-200 with +12V Supply
F = High Performance BC/BCX-300 with +12V Supply

REF SYM	DESCRIPTION	PART NUMBER
T101	WHERE (CONT.): G = High Performance BC/BCX-200 with +15V Supply H = High Performance BC/BCX-300 with +15V Supply *See Page 1-1 for Diagram	
U101	TDA1170S	1-025-0126
U102	MC1391	1-025-0114
VR101	OPTIONS:	
	A — Z0405, 15V	1-021-0405
	B — Z0517, 18V	1-021-0517
	WHERE: A = Any Model with +12V Supply B = Any Model with +15V Supply	
VR102	IN4752A, 33V	1-021-0419

REF SYM		DESCRIPTION	PART NUMBER
R146	OPTIONS:		
	Standard Model:	12.1K-1/4-1	1-011-2755
	High Performance Model:	8.2K-1/4-5	1-011-2637
		10K-1/4-1	1-011-2754
R147		.47-2-10	1-011-1394
R148		2.4K-1/4-5	1-011-2584
R149			
R150	OPTIONS:		
	Standard Model:	2.7K-1/4-5	1-011-2588
	High Performance Model:	2.4K-1/4-5	1-011-2584
		10K-1/4-5	1-011-2554
R151		1K-1/4-5	1-011-2553
R152		1K-1/4-5	1-011-2553
R153		81-1/2-5	1-011-2244
R154		33-1/4-5	1-011-2596
R155			
R156	OPTIONS:		
	BC-200:	NOT USED (W105 USED)	
	BC-300:	2.7M-1/4-5	1-011-2591
		VAR, 5M-1/4-20	1-011-5711
R157		1K-1/4-5	1-011-2553
R158		1.8M-1/4-5	1-011-2726
R159		20K-1/4-5	1-011-2578
R160		2.7M-1/4-5	1-011-2591
R161			
R162		NOT USED	
R163		8.2M-1/4-5	1-011-2640
R164		100K-1/4-5	1-011-2555
R165		VAR, 250K-1/4-20	1-011-5759
R166		47K-1/4-5	1-011-2614
R167		10K-1/2-5	1-011-2294
R168		10K-1/2-5	1-011-2294
R169		10K-1/4-5	1-011-2554
R170		10K-1/4-5	1-011-2554
R171		220K-1/4-5	1-011-2582
R172		10K-1/4-5	1-011-2554
T101	OPTIONS:		
	A*	FLYBACK TRANSFORMER	1-017-5470
	B*	FLYBACK TRANSFORMER	1-017-5479
	C*	FLYBACK TRANSFORMER	1-017-5474
	D*	FLYBACK TRANSFORMER	1-017-5480
	E*	FLYBACK TRANSFORMER	1-017-5484
	F*	FLYBACK TRANSFORMER	1-017-5494
	G*	FLYBACK TRANSFORMER	1-017-5485
	H*	FLYBACK TRANSFORMER	1-017-5495

WHERE:
A = Standard BC/BCX-200 with +12V Supply
B = Standard BC/BCX-300 with +12V Supply
C = Standard BC/BCX-200 with +15V Supply
D = Standard BC/BCX-300 with +15V Supply
E = High Performance BC/BCX-200 with +12V Supply
F = High Performance BC/BCX-300 with +12V Supply

REF SYM	DESCRIPTION	PART NUMBER
T101	WHERE (CONT.): G = High Performance BC/BCX-200 with +15V Supply H = High Performance BC/BCX-300 with +15V Supply *See Page 1-1 for Diagram	
U101	TDA1170S	1-025-0126
U102	MC1391	1-025-0114
VR101	OPTIONS:	
	A — Z0405, 15V	1-021-0405
	B — Z0517, 18V	1-021-0517
	WHERE: A = Any Model with +12V Supply B = Any Model with +15V Supply	
VR102	IN4752A, 33V	1-021-0419

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